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A Phase of the Wage Question.
A Hydraulic Governor for Rolling Mills.
Uses and Advantages of a Supply of Compressed Air.
Reversed Momentum.
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NINETEENTH YEAR.

No. 17.
April 23
1896.

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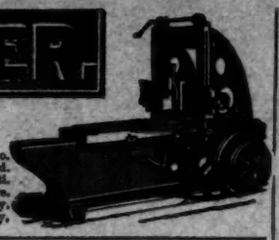

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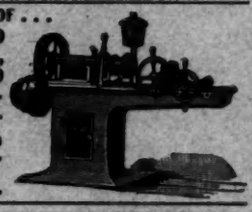

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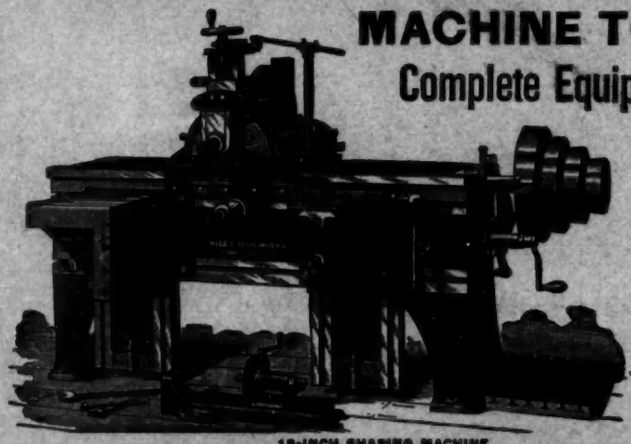

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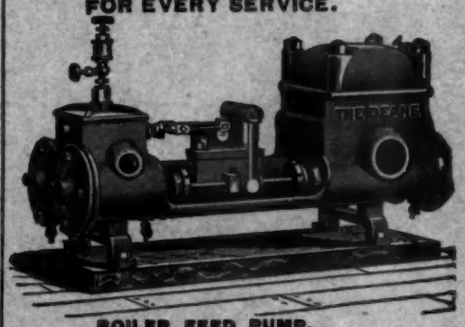

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NEW YORK, THURSDAY, APRIL 23, 1896.

VOLUME 19. NUMBER 17.

High-Pressure Air Compressors of the Pneumatic Gun Battery at Fort Winfield Scott, San Francisco, Cal.

BY B. C. BATCHELLER, S. B.

It frequently happens in the mechanical world that the development of a new industry, appliance or machine incidentally creates a demand for some auxiliary appliance or apparatus. We have an example of this in connection with the pneumatic dynamite gun. No sooner was the gun conceived in the mind of the inventor than the question arose, How shall the compressed air be obtained to operate it? The steam air compressor naturally suggested itself as the most practical means of supplying the want. Experiments had not progressed very far before it was seen that, to obtain long ranges with a gun of this kind, high pressures must be used. With the first gun built—a 2-inch—the air pressure was finally carried up to 500 pounds per square inch. This was a high pressure when compared with the pressures used for operating rock drills; but everything is relative in this world. When compared with pressures now used, 500 pounds is considered low. The third gun that was built—an 8-inch—was designed and operated with air at 1,000 pounds pressure per square inch. This is the pressure used in the guns at the present day; and it is probable that this is the limit beyond which we shall never go, so far as the gun itself is concerned, for the simple reason that there is very little gained in range by using higher pressures. The air becomes so dense and heavy at higher pressures, that almost as much energy is consumed in accelerating it along the bore of the gun as is consumed in accelerating the projectile. Unless the relative weight of the projectile be greatly increased, the small gain in muzzle velocity realized by using higher pressures is more than offset by the necessary increase in strength of pipes, reservoirs and working parts, as well as the greater difficulty of maintaining tight joints.

In order to discharge many rounds from the pneumatic guns without running the air compressors, as the conditions of military use require, the compressed air must be stored in suitable receivers, from which it can be drawn to fill the gun. Since the air will only flow from a higher to a lower pressure, the storage receivers must be filled to a higher pressure than is used in the gun, or above 1,000 pounds per square inch. It has become the practice to fill the storage receivers to 2,000 pounds. Thus a demand has been created for air compressors capable of supplying large quantities of compressed air at this high pressure of one net ton to each square inch.

The first machines for this service were built by the Norwalk Iron Works, of South Norwalk, Conn., and two of their machines may be seen to-day on board of the United States steamship "Vesuvius." A battery of three pneumatic guns, located at Sandy Hook, N. J., are supplied with compressed air by two machines designed and constructed by the Rand Drill Co., of New York. I do not mean to say that the machines built to be used with the pneumatic guns are the only high-pressure machines in use, but I think I can say that they are the largest. Small machines, such as those built by Brotherhood in England, are used on board torpedo boats to supply compressed air at 1,750 pounds for launching torpedoes. Quite a number of high pressure machines have been built for compressing and liquifying gas.

It is the purpose of this article to describe two machines recently designed by Mr. Edward A. Rix, of San Francisco, Cal., and built by the Fulton Engineering & Ship-Building Works, of the same city, for the pneumatic gun battery of Fort Winfield Scott. The writer believes these to be the largest air compressors ever constructed to supply air at 2,000 pounds pressure. Their combined capacity is 450 cubic feet of compressed air per hour, which is equivalent to 61,713 cubic feet of free air per hour. The machines are able to supply considerable in excess of this amount. Their rated speed is 100 revolutions per minute, and their indicated horse-power under full load is 350 each. The stroke is 24 inches.

The general arrangement and design of the machines are shown in Figs 2 and 3, and a perspective view in Fig. 4. They are of the compound duplex type, consisting of two double-acting high-pressure steam cylinders, two double-acting low-pressure air cylinders, one single-acting intermediate air cylinder and one single-acting high-pressure air cylinder. The cylinders are disposed in two lines of three each—on one side a steam cylinder, low and intermediate air cylinders; on the other side a steam cylinder, low and high-pressure air cylinders. By this arrangement the work is very nearly equally divided on the two sides. The cranks are set at 145 degrees, this angle being chosen as giving a better equalization of work throughout the revolution, and allowing the engines to start at any position of the cranks.

The steam cylinders are 20 inches diameter, and are fitted with the Meyer hand-regulation cut-off valves. The steam pressure usually carried in the boilers is 100 pounds, and the engines ran under full load, cutting off at 3/8 stroke. (See steam card, Fig. 10.)

Fig. 1. BATTERY OF PNEUMATIC DYNAMITE GUNS. FORT WINFIELD SCOTT. SAN FRANCISCO, CAL.

In Figs. 3 and 4 will be seen what looks like an ordinary centrifugal governor. This is not a governor, but a device for automatically closing a valve in the steam pipe when the speed of the machines rises above a fixed limit. In other words, it is a safety device to prevent the engines from racing when the load is suddenly thrown off.

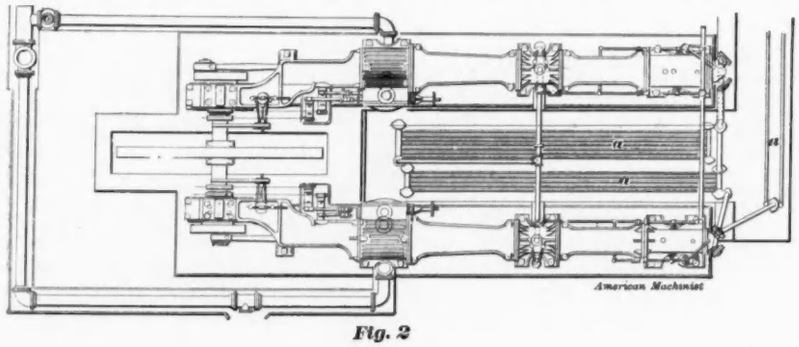


Fig. 2

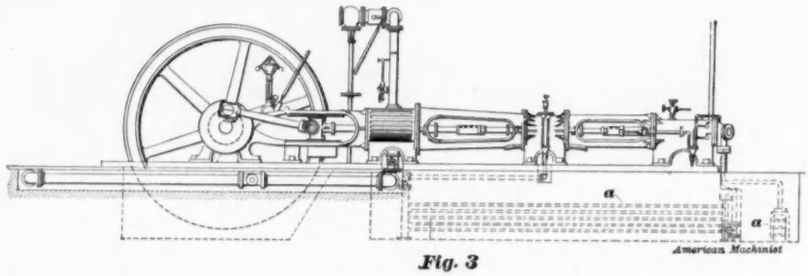


Fig. 3

The low-pressure air cylinders are placed next to the steam cylinders. They are double-acting, with pistons packed in the usual manner, by cast-iron rings sprung into place. The intermediate and high-pressure air cylinders are single-acting, with plungers. The intermediate plunger is packed with soft packing in the ordinary form of stuffing box. The high-pressure plunger is packed with sectional babbitt and brass rings. This has proved a very satisfactory form of packing for high pressures. It does not leak when properly made, and the friction is not excessive. The valves are all of the poppet type, carried in bronze casings, making it possible to quickly remove the valves and their seats when they need examination.

One of the most interesting features of these machines is the system of cooling the air. The air cylinders and cylinder heads are water-jacketed. The jackets are divided by partitions, to insure a thorough circulation in all parts of the jacket. Water also circulates within the plungers of the intermediate and high-pressure cylinders. This is a very important feature, for otherwise the plungers become very hot from contact with the air and from the friction of their packing. The water is conveyed to and from the moving plungers through telescoping pipes. The water from each jacket, head and plunger is discharged into an open drain, so that the temperature of the water and the quantity flowing can be observed at all times. These discharge pipes can be seen in Figs. 5 and 6. The accessibility of all parts of these machines is one of their best features.

After each stage of compression, the air is passed through a series of copper pipes surrounded by water, which reduces its temperature below the initial atmospheric temperature. These systems of cooling pipes, known as "intercoolers," are located in a large tank formed in the concrete foundation of the machines. This is a very convenient disposition; for they are out of the way under the floor, are very accessible, and the connections to the cylinders are very short. The cooling surface of the intercoolers is diminished with each stage of compression, as the air diminishes in volume. The air is delivered to the storage receivers at a temperature not above that of the atmosphere. The intercoolers can be seen in Figs. 2 and 3, at *a*.

Before the machines were formally turned over to the United States Government, they were subjected to a test with some interesting results. Indicator cards were taken from all the cylinders, including the high-pressure air cylinder. So far as the writer knows, indicator cards of 2,000 pounds pressure were never taken before, and credit is due to Mr. George Kingsland, superintendent of the Fulton Engineering Works, for securing these cards. After applying to one of the well-known firms who manufacture indicators, for an instrument suited to these high pressures, and being informed that they could not supply his demand, he constructed attachments for a standard Thompson indicator which enabled him to obtain the cards. These attachments consisted of a cylinder and piston reduced in diameter sufficiently to use the regular 100-pound spring. The attached cylinder was screwed to the indicator, directly below the regular cylinder, with an extended piston rod. The indicator was calibrated by attaching it, with a standard gage, to one of the air receivers filled to 2,000 pounds.

A card from each of the cylinders is shown in Figs. 7, 8 and 9, and the air-cylinder cards have all been plotted to the same scale in Fig. 11. The scales of the springs are given on the cards, that of the intermediate air cylinder being open to the uncertainty of its not having been calibrated.

The indicated horse-power of the steam cylinders was found to be 351.64 horse-power. This is the mean of five pairs of cards, all reduced to 100 revolutions per minute. The combined horse-power of the air cylinders is 286.75 horse-power. The latter is 81.5 per cent. of the former. The difference is 64.89 horse-power, which represents the friction of the machine.

The theoretical horse-power of single-stage adiabatic compression, for the same piston displacement, is 530 horse-power.

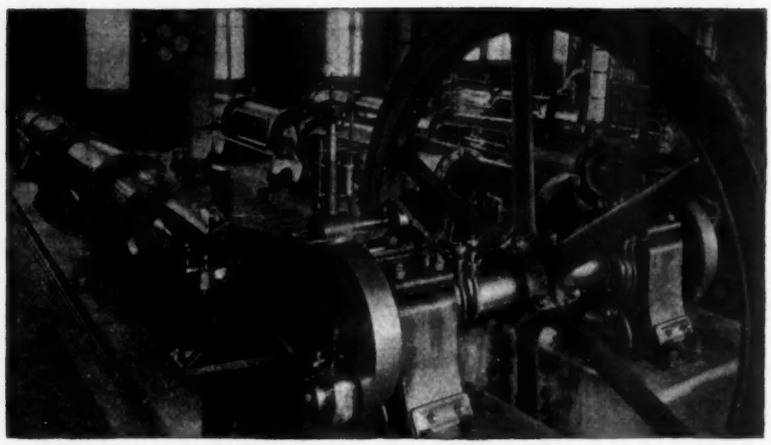


Fig. 4. AIR COMPRESSORS.

Gages showed the pressure of the discharge of each air cylinder to be:

Low-pressure ..... 75 pounds.
Intermediate ..... 375 "
High .....2,000 "

Temperatures of the air in the suction and discharge pipe of each of the air cyl-

inders, show how effective and well-proportioned is the cooling system. These temperatures are given in the following table, also the theoretical temperature of adiabatic compression:

	Temperature of Suction.	Temperature of Discharge.	Temperature by Adiabatic Compression.	Difference.
	Deg.	Deg.	Deg.	Deg.
Low-pressure cyl...	75	320	444	124
Interm. press. cyl...	73	289	355	66
High-pressure cyl...	69	358	392	34

These records are interesting in showing how much heat is abstracted by the intercoolers and water jackets. The difference between the temperature by adiabatic compression (that is, without loss of heat) and the observed temperature of the air in the discharge pipe of each cylinder, is almost in direct proportion to the surfaces of the cylinders.

The temperature of single-stage adiabatic compression to 2,000 pounds is 1,769 degrees.

While filling the storage receivers, the temperature in the discharge pipe of the high-pressure cylinder was observed at varying pressures and recorded in the following table:

Pressure in Storage Receivers.	Temperature of High-Pressure Discharge.
Pounds.	Degrees.
800	189
900	202
1,000	223
1,100	233
1,200	265
1,300	273
1,400	292
1,500	293
1,600	307
1,700	320
1,800	340
1,900	346
2,000	358

Fig. 12 shows the bank of storage receivers which contain compressed air at 2,000 pounds pressure per square inch, and the gages which indicate the pressure in the receivers and in the guns. The stop valves under the gages distribute the air to the guns and other points, These are 2-inch valves operated by hand. The receivers are lap-welded wrought-iron tubes, 25 feet long, 16 inches outside diameter, and $\frac{13}{16}$ inch thick. As will be seen in the figure, they are connected into three bronze manifolds by $\frac{5}{8}$-inch copper pipes.

Since the guns and compressing plant was formally turned over to the United States Government, the air compressors have been frequently run by the officers and soldiers of the Fifth United States Artillery with satisfactory results, so far as the writer knows.

Uses and Advantages of a Public Supply of Compressed Air for Elevators.

BY FRANK RICHARDS.

In direct-acting lifts, which I spoke of in my last paper, April 2d, under the above general title, compressed air is entirely without a competitor. For simplicity, convenience, quickness and cheapness there is, in that line of service, nothing in sight to be compared with it. But the work of the suspended direct-acting hoisting cylinder represents only a small part of the hoisting that is to be done in any city. Business life is now absolutely dependent upon the passenger elevator. The office building of to-day, crowded with hurrying throngs going in and out, and up and down, would be tenantless without it. The elevator may be said to be in every building, and to be the life of every building of any importance.

The elevators in use are operated by at least three different styles of motors—steam, water and electricity—and each style is quite numerously and efficiently and respectably represented. The list should perhaps be made four instead of three, as the steam service should be divided into the service by special engines having no other duty but the operating of the elevator, and the service connection with a running line of shafting driven by steam, but driving various other machinery besides that of the elevator.

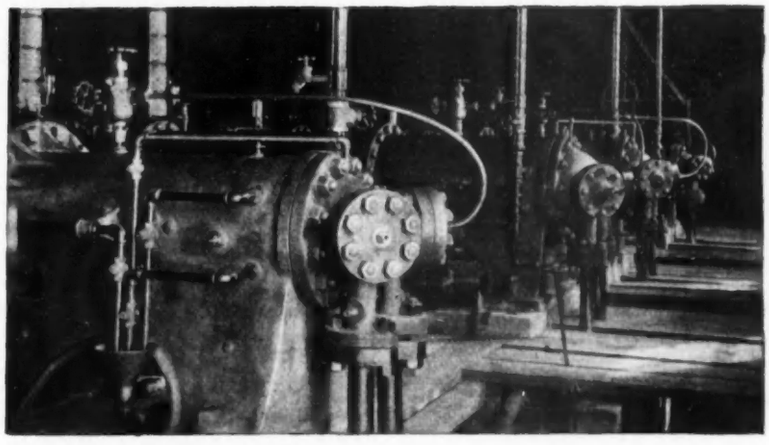


Fig. 5. INTERMEDIATE AND HIGH-PRESSURE AIR CYLINDERS.

Whichever may be the style of elevator employed, compressed air (drawn from our "Compressed Air Company's" pipes, at 100 pounds pressure, and at our established price of 5 cents per thousand cubic feet of free air) is readily applicable to either of them, and usually the application may be made without much change of apparatus.

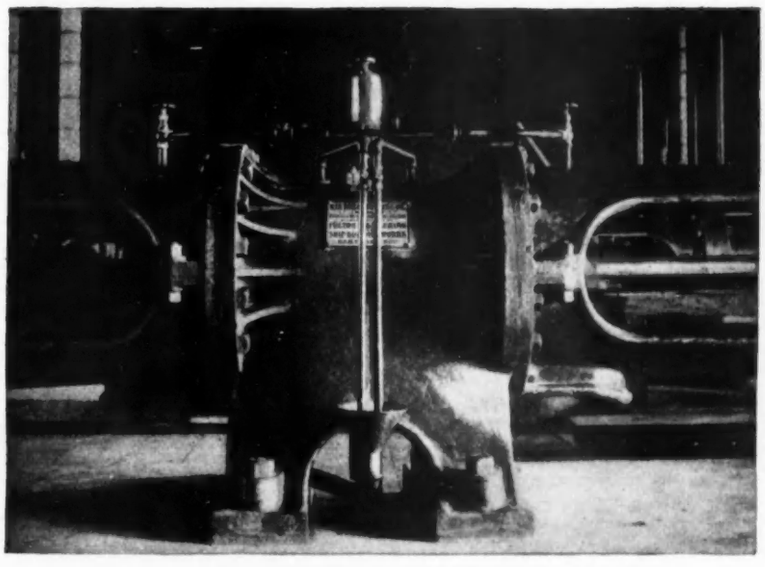


Fig. 6. LOW-PRESSURE AIR CYLINDERS.

The water pressure elevators now in use are in some cases operated by water direct from the city mains. Where the water pressure is sufficient, and sufficiently reliable, and where there is an inex-

haustible supply of water, this may do; but in most cities neither of those conditions are found, and at best the city mains can only be expected to operate elevators in private houses, where the duty is light and the calls are infrequent. It may be said that almost invariably with the water-operated elevators in use, the water is furnished by steam pumps in operation in the building where the elevator is employed. If a pressure of 100 pounds is sufficient with water, it will, of course, be

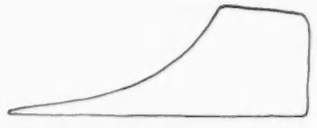


Fig.7 High Pressure Air Cylinder Scale 1400

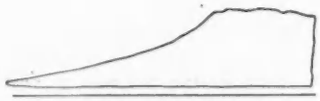


Fig.8 Intermediate Air Cylinder Scale 367

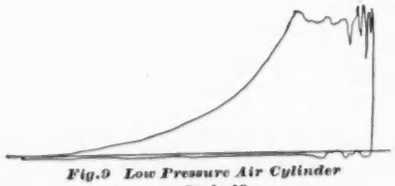


Fig.9 Low Pressure Air Cylinder Scale 40

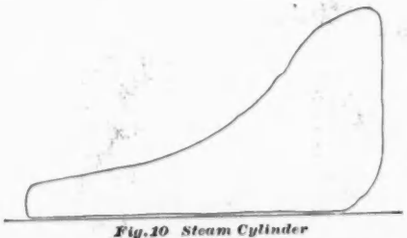


Fig.10 Steam Cylinder Scale 40 *American Machinist*

sufficient with air, and all that would be required would be to make the pipe connections and employ a different controlling valve. In some cases the elasticity of the air makes it somewhat objectionable for elevator service, although less effect of the elasticity is realized than might be anticipated. Where there is such an objection, the water may still be used in the operating cylinder of the elevator, as before, using it over and over, while the pressure may be applied to the water by means of the air. This arrangement is already frequently employed upon foundry cranes and similar places. If the water is used at a very high pressure, our 100-pound supply of air is equally available by means of a differential piston, a larger piston being employed for the air pressure and a smaller piston for the water. Air employed here or elsewhere has the advantage over water that only the pressure will be used that is required for the work in hand. While a pressure must be maintained sufficient for the heaviest loads, that pressure will not be needed and will not be used for the lighter loads, and the volume of free air used, and to be paid for, will vary with the load. With a given water pressure maintained, sufficient for the heaviest load that it can carry, the volume of water used, and the power required for forcing that water, will be the same whether the elevator carries up its heaviest load or carries no load at all.

A wonderfully inexplicable fact it is, that in the cities of Great Britain, notably in London and in Glasgow, a public hydraulic service is maintained and has many customers, and is found feasible and reasonably profitable notwithstanding the narrow limits of its adaptability and the waste of power necessarily involved in its operation, and the further fact that an air supply would do everything that the water service will do, would do it cheaper and better in every way, and would be applicable to a vastly wider range of service. At any given pressure of transmission, equal volumes of air and of water will,, of course, transmit equal power, and the same size of service pipe would transmit ten times the volume of air as of water, or ten times the power by means of air as where the water was used, doing the work where employed much more economically with no shock to the pipes or valves, with no freezing-up in transmission, with no cost for the fluid transmitted and no possibility of loss thereby. If it pays, as it evidently does, to maintain the hydraulic service, the success of a pneumatic service must be inevitable.

In general, it may be said that in all hydraulic elevators where the pressure of the water upon a piston in a large cylinder is made to operate the lift or elevator, either directly and at the same speed as the piston, or by multiplying sheaves at a much greater speed and to a much greater height, the air service may be substituted for the water to advantage, and the public supply may be substituted for the private pump and tank system with a considerable saving. When it comes to the steam-operated elevators, the air motor is beautifully applicable. As to the cases where the elevator is driven from line shafting running constantly and transmitting considerable power for other purposes, the question hinges upon the total amount of power employed. I am inclined to think that the question does not, or should not, begin to arise until the constant amount of power required goes considerably above fifty horse-power. For the actual steam-operated elevators, where a special engine is directly connected to the drum system and has no other work to do, there cannot be a moment's question of the desirability of the air service. Anyone who has had any experience with compressed air in steam engines knows how prompt, how free and lively is the action. No matter how infrequent may be the calls for it, there is never any hesitation about the start, always the most perfect control,

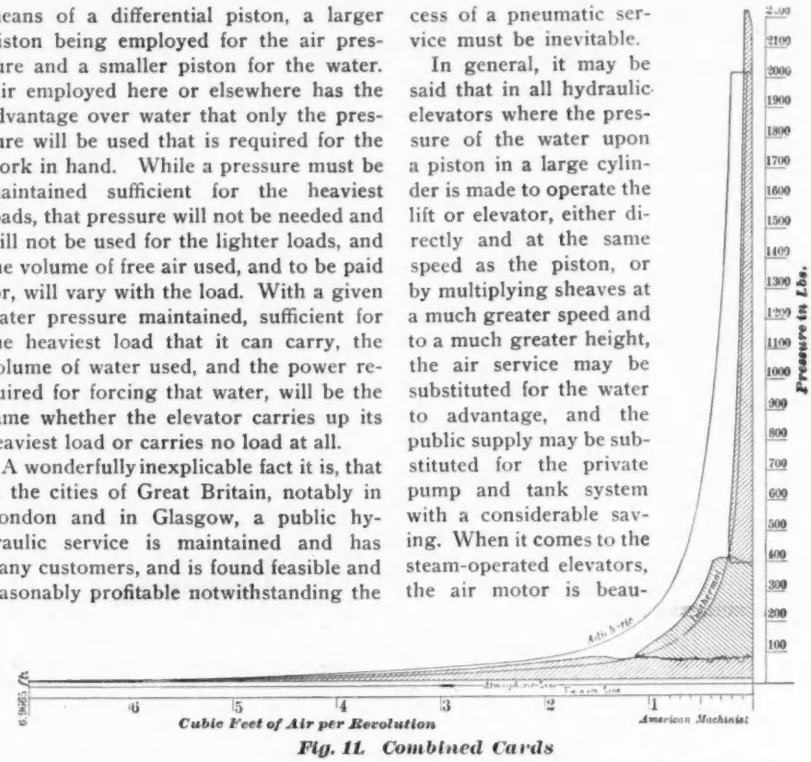


Fig. 11. Combined Cards

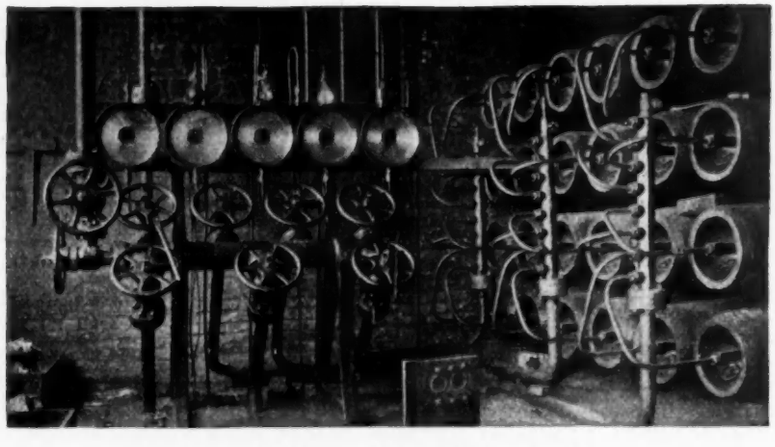


Fig. 12. STORAGE RECEIVER AND GAGES.

and no cost except for the actual running. The air motor is as precisely adapted to operate the elevator that may be driven by the electric motor as any other—of course, by the substitution of a suitable motor and gearing. While mechanically the electric current can do little except by rotary motion and high speed, compressed air can do all that and much more. The speed of revolution of the air motor is generally better adapted to practical uses than that of the electric motor.

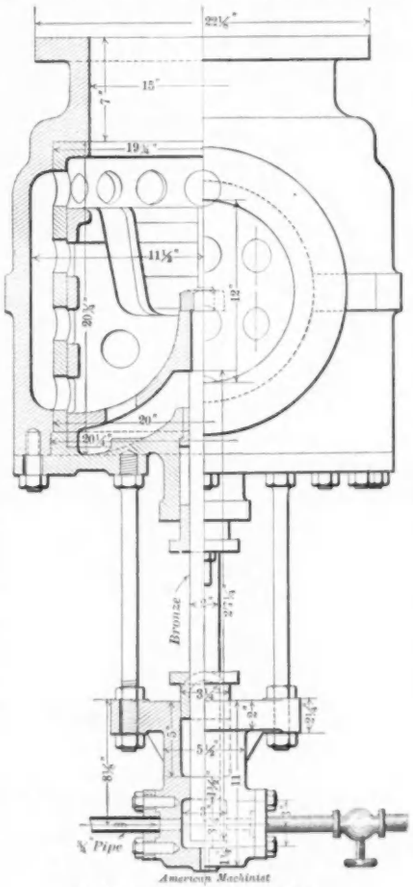
▲ ▲ ▲

Hydraulic Governor for Rolling-Mill Engines.

We illustrate herewith a novel form of governor employed on the blooming-mill engine at the Pencoyd Iron Works. It is an excellent solution of a difficult problem, as well as an illustration of the almost instinctive manner in which rolling-mill engineers turn to hydraulic pressure for the solution of problems which arise in their field of work.

The blooming mill is, as is well known, the heaviest mill about a steel works. It takes the ingots as they are cast and reduces them to blooms. It is almost always a "two-high" reversing mill, the ingot being passed through it backward and forward as its size is reduced. The engine is necessarily a double engine, with cranks at right angles, and geared to a shaft which forms an extension of the lower roll. The reversal of the rolls involves, of course, the reversal of the engine, which must be done repeatedly and at full speed as the work progresses. To make this reversal without loss of time requires that the engine shall have no fly-wheel. At the instant of reversal the engine has no load other than that due to the turning of the rolls, but soon the ingot enters the rolls and the full load comes on the engine practically instantaneously. Such conditions will be recognized as practically impossible to meet with the centrifugal governor. Such a governor must be stopped and reversed with the engine. As the balls slow down, they give more steam just as it is not wanted; and, moreover, the inertia of the balls resists the stopping in the first place, and the starting in the reverse direction in the second place, and so leads to slipping of the belt. The governor thus lags behind the engine and gives full steam after the reverse gear is thrown over, and at a time when the engine is not under load. The engine is thus under full steam until the inertia of the balls has been overcome, and the speed of the governor has been brought up to that of the engine. The absence of a fly-wheel makes the reversal very sudden, making it still more difficult for a belt-driven governor to act with sufficient promptness. In consequence of these difficulties hand regulation is usually depended on; but it will be seen at once that with the great size of the engines, and the instantaneous application and release of the load, the operator must be constantly on the alert, as a failure to throw the steam off or on at the proper instant would lead to the racing of the engine or the stopping of the same, and the sticking of the ingot in the rolls.

The governor shown overcomes all these difficulties. Its control of the engine is absolute and independent of the skill or quickness of the operator. The engraving will make the construction clear The 15-inch steam main is connected to the top of the governor body. The steam passes down inside the balanced



HYDRAULIC GOVERNOR.

throttle valve, from whence it passes through the perforations and divides between the two 12-inch branch pipes leading to the cylinders. The valve is controlled by hydraulic pressure through a plunger and pressure cylinder, shown at the bottom. The engine to which the governor is attached drives directly from its crank shaft a small pump, which delivers its water or oil (the latter being found preferable, we believe) to the pressure cylinder through the pipe shown at the left. This oil is returned to the suction side of the pump through the pipe and regulating valve shown at the right. The regulating valve is so adjusted that, when the engine is running at the desired speed under load, the oil returns to the pump as fast as it is delivered to the governor, without creating enough pressure in the pressure cylinder to raise the plunger. When, however, the engine increases its speed in consequence of a diminished load, the pump delivers more oil to the governor, which cannot return through the restricted opening of the valve without increasing the pressure in the pressure cylinder. This increase of pressure raises the plunger and shuts off the steam. When the load comes on the engine again, a slight drop in speed occurs, which causes the pump to deliver less oil. The oil pressure then drops, the steam pressure upon the plunger forces it down, opening the valve, and the engine has full steam again.

The action of the governor is surprisingly good. The writer saw it in operation, and the change in speed as the load came on or off was so slight that he was unable to decide whether it could be seen by the eye or not. Of course, under the conditions, it is a case of full load or no load, and under the usual conditions of motive-power engines it might easily be that the system would not be satisfactory; but for the purpose to which it is applied the regulation is certainly all that can be desired, and the governor is an excellent illustration of a special design to meet special conditions. The engine to which it is applied is a two-cylinder, 40 x 60.

Why is not this system of governing applicable to marine use? With a ship in a heavy sea the conditions are essentially the same as with a roll-train engine. In both cases it is a matter of full load or no load, with rapid changes from one to the other. Minutely accurate regulation of of speed is not necessary in either case, the object being to prevent racing and to meet the changes of load with promptness. The governor meets these conditions perfectly with the rolling-mill engine, and we can see no reason why it should not do it equally well with a marine engine.

▲ ▲ ▲

What is understood to have been the largest contract for turbines and appurtenances ever made was recently placed by the Lachine Rapids Hydraulic & Land Co., of Montreal, Can. Sixty-six 54-inch cylinder gate Victor turbines were ordered with gearing, shafting, etc., for electric generators, the power to be electrically transmitted to the city for street railway and lighting purposes.

▲ ▲ ▲

When you have a supply of compressed air in the shop, the more storage capacity you have for it the better; it is well also to have the receivers distributed around rather than to have them all together. At the Meadville shops of the Erie road, when it is desirable to move locomotives around their boilers are filled with compressed air, and they are run about with that instead of filling with water and firing up. Here especially an ample receiver capacity would be appreciated, as the greater such capacity the quicker the boiler would be charged.

ELECTRICAL MACHINERY.

The Building of a Great Dynamo—IV.

The hand sketch 15 *A* shows the general construction of the "winding" of the armature, of which the commutator bars form the outer surface, and the *U*-shaped pieces the sides and inner surface. The thin tenon ends of the *U*-piece go one tenon in one commutator bar, and the other tenon in the opposite end of the adjacent bar, which, as will be readily understood, makes a real "wind" or continuous spiral. This spiral, except for the intervening insulation and the projecting core bolts and their nuts, completely envelopes the insulated armature core.

It will be seen from the hand sketch Fig. 15 *A* that when the chisel is applied as shown in the section, to cut off the ends of the *U*-bars which project above the commutator bars, the longitudinal cuts *a b c* in the free ends of the *U*-bars make vastly easier work of chipping away this

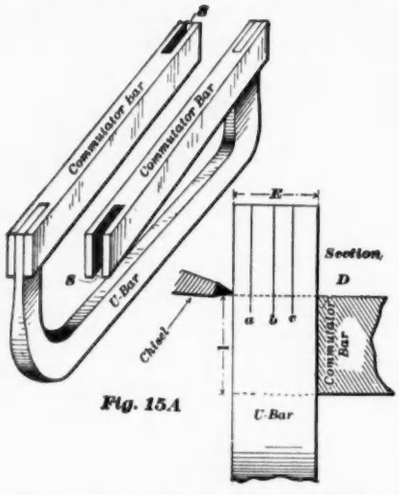


Fig. 15A

surplus than if the ends were left all in one piece. Also, when the free end is cut off with the chisel directed as shown in 15 *A*, the right-hand surface of the *U*-bar is forced over into the locking cut formed with a boundary line *D*, so that the top inside corner of the *U*-bar hooks into this locking cut and holds the *U*-bar up in place for soldering the *U*-bar and commutator bar together. The "slate-frame joint" cuts at *S S*, Fig. 15 *A*, are made on a special commutator-bar sawing or milling machine, Fig. 16. The saws are of various thicknesses for various thicknesses of commutator bars. In the present case the saws are 4 inches diameter and ⅛-inch thick. They make 1,000 turns per minute with a flooded water lubrication—water only. This one machine turns out about 1,000 commutator bars per day, sawed at both ends. Copper is well known as a difficult metal to work with cutting tools, and the present case does not show any great advance over previous results. The cuts are made quickly, but with a very unpleasant tearing and crushing noise, and the saws have to be sharpened for every 200 bars cut. The spindles adjust to and from each other for differing lengths of bars; the bar is held in two vises, one at each end, also adjustable to length of bar. The vise jaws are rock-shaft and crank-operated, the crank-rod driven block being adjusted to exact position so that the crank stands on the center when the vise jaws are closed on the work. The knee which carries the ways for the two vises has a vertical feed action through the rocker, rocker arm, and a connecting rod shown plainly in Fig. 16. The knee feed rocker is operated by the very long hand lever in front.

Provisions are made for adjusting the length of this hand lever by sliding it in a crossway on the end of the rocker, but the operator had it out full length and swept it through a great arc, as high as he could handily reach and almost down to the floor. There was a full half-inch stream of water on each saw; both machine and operator were covered with copper dust, and there was a thick scum of copper floating on top of the water in the tray in which the machine stands. The saws are coarse-pitched, well-shaped teeth; but the cut jarred the solid floor in a way to set a tool-maker's teeth on edge. There are a great many copper cuts in the electric shops, but not one has come under observation in such form as to be tolerated on any other metal. The foreman in charge had never tried less cutting-edge velocity, and in no case noted have the usual milling speeds been used on copper. At a thousand revolutions, a 4-inch saw has over 1,000 feet surface velocity, and the copper everywhere afloat showed anything but a good clean cut. The machine shown in Fig. 16 is put up on a well-shaped box base, the spindles stand at right angles to the countershaft, and the details are well thought out for rapid action. The maker's name did not appear. The machine seems heavy enough for the cuts, but its action was indescribably unpleasant, noisy and irritating. The cut was made in about 7 seconds.

The cuts *a b c*, Fig. 15 *A*, are made with a gang of saws in a little hand milling

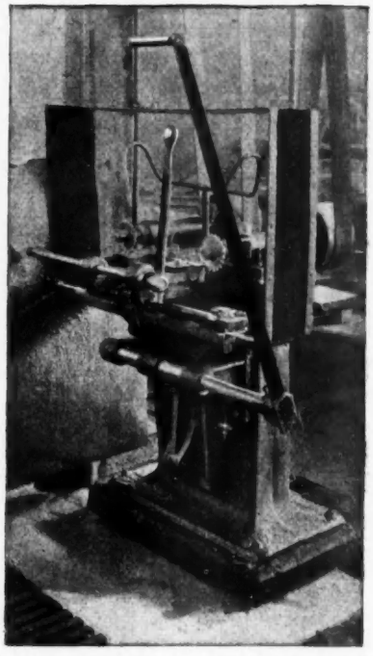


Fig. 16. OUTSIDE BAR SAWING MACHINE.

machine, the tops of the saws standing up through slits in a table above the saw arbor; this cut I did not see made.

The insulation of the U-bars consists of linen tape wound round the bar ends after a strip of mica has been applied to one side only. As the U-bars, when put in place, touch each other, there is consequently an insulation

Fig. 17. PLACING COMMUTATOR BARS.

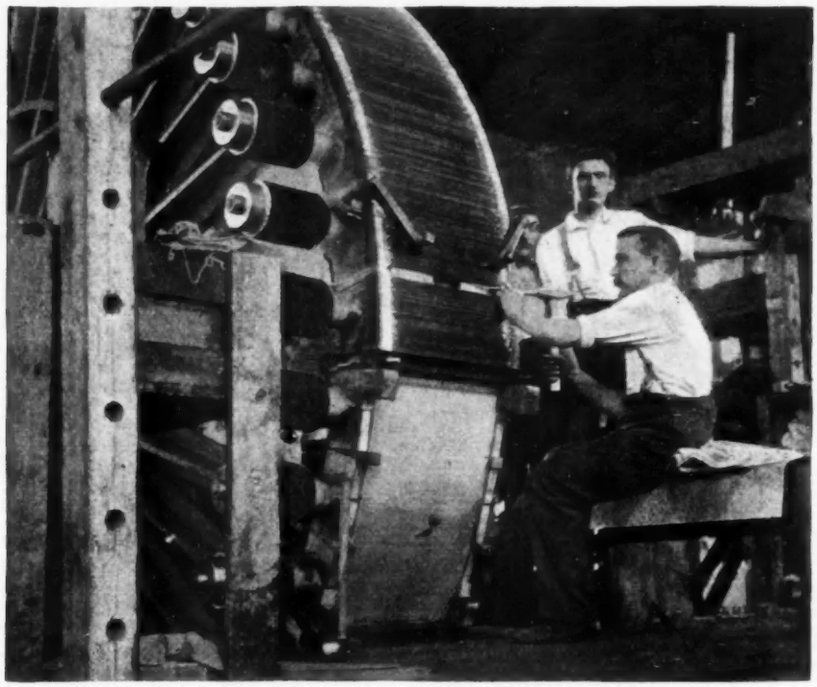


Fig. 18. PLACING COMMUTATOR BARS.

of two thicknesses of tape and a mica plate between adjacent U-bar surfaces. The tape winding is secured with beeswax, by dipping the end of a stick of wax into a shallow tray of melted wax kept hot by standing on a hot iron plate; this makes the end of the wax stick soft enough to spread on the tape end and hold it tight enough on the U-bar to permit considerable handling. As the U-bars and commutator bars are all driven up tightly against the insulation between them as the winding of the armature core with the bars proceeds, this beeswax holding is quite sufficient for the requirements of the case.

Fig. 17 shows two workmen engaged in applying the winding to the insulated armature ring. The "star" of this small ring is keyed on an arbor with wooden wedges, and the arbor is laid in open wooden boxes on top of substantial horses, so that it can be readily revolved when desired, all as clearly shown in Fig. 17. First two clamps with finished faces are bolted on the insulated armature ring a short distance apart, and a commutator bar, with its ends sawed and tinned, is laid against the finished face of the lower clamp; a strip of insulation is then laid on the upper side of the commutator bar and another bar is laid on this insulation; then a U-bar has its thin, free ends slipped into opposite ends of the two commutator bars; then another strip of insulation is laid on the side of the top commutator bar, the third commutator bar is laid against it, and the second U-bar is put in place—one end in the unoccupied cut of the second commutator bar, and the other in the opposite end of the third commutator bar, and so on until the space between the two clamps is tightly filled; then the top clamp is moved along on the armature ring and the process continued in the same manner. There is a great deal of wedging with wooden wedges and driving with hand hammers all through this winding operation, which is slowly and most carefully performed, the greatest care being taken to have the whole mass of bars and insulation driven up and compacted as closely as possible, so that nothing can work loose when the armature ring is driven at its high working speed.

Fig. 17 shows workmen operating on a small armature ring; Fig. 18 is a partial view of the 1,500 horse-power armature ring in process of winding. Two U-clamps and one pair of flat clamps are in use, and two pairs of wooden wedges are employed to force the bars close together, the process being the same for all sizes of armature rings. H. L. A.

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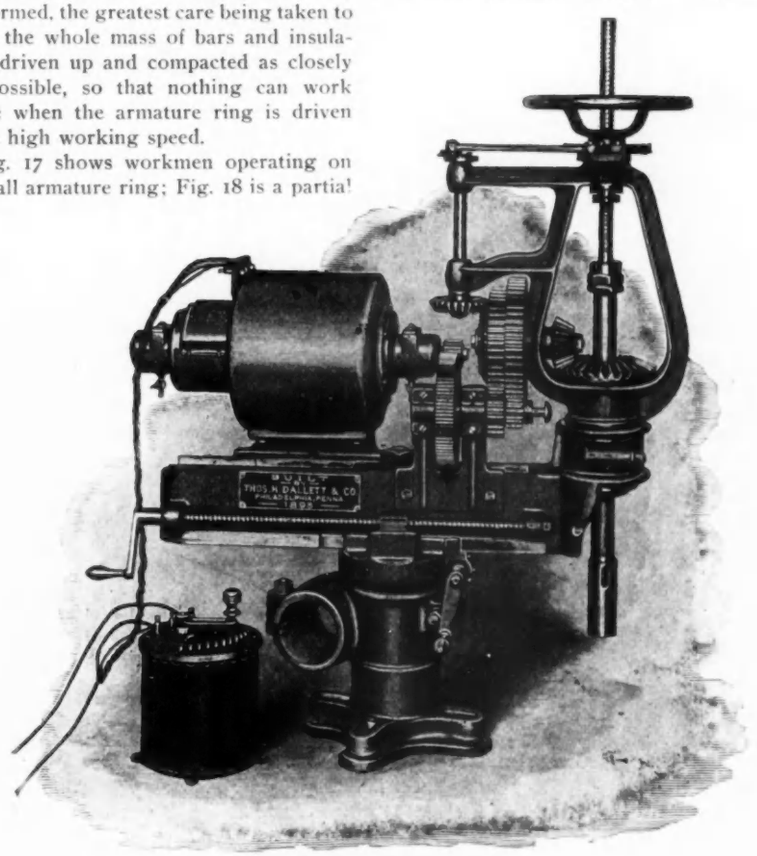
A Portable Electric Drill.

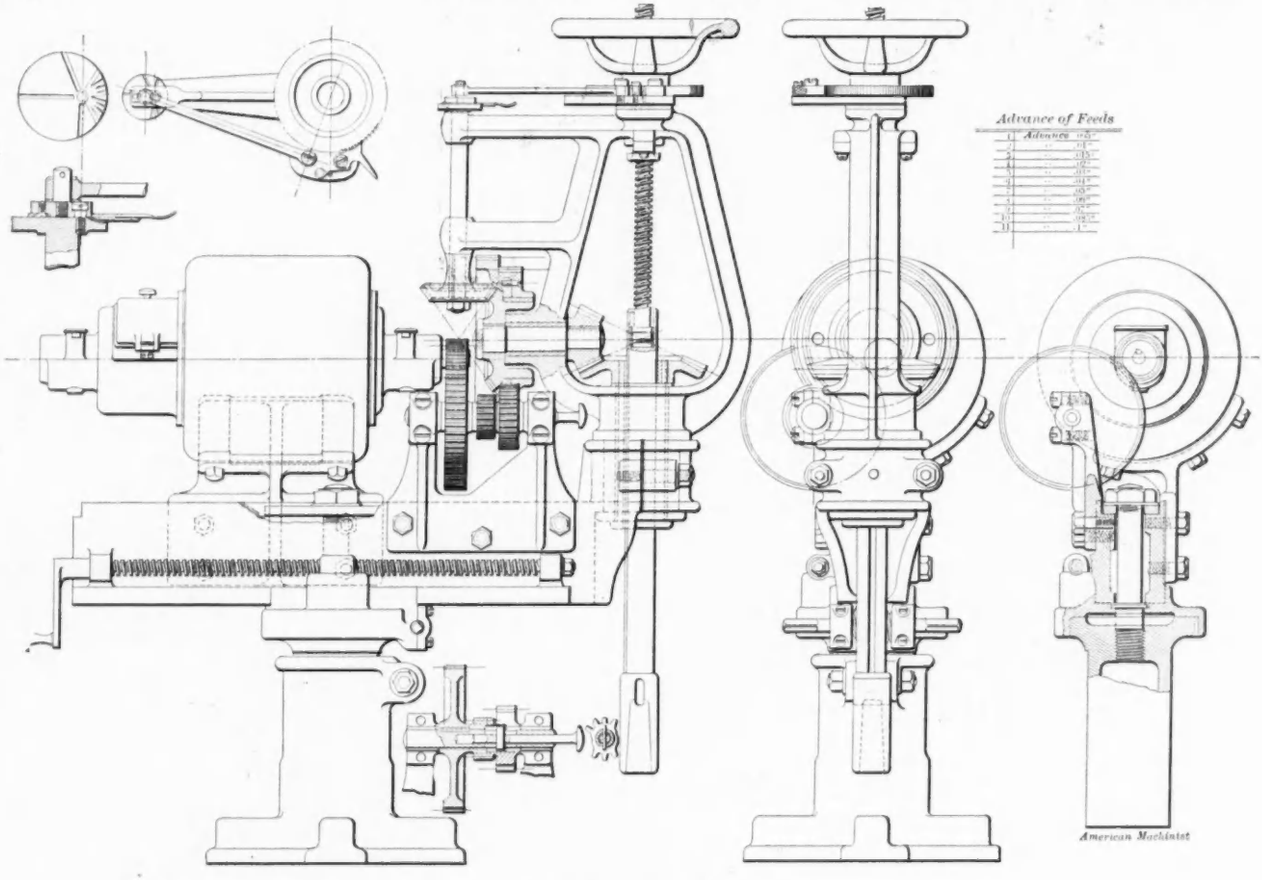
We illustrate a portable electric drill which is without the defects of the usual portable tools, being complete in itself, entirely self-contained and without anything of a make-shift character about it. With this machine there is no fastening of the drill in one place and the motor in another, with a flexible shaft, a telescope shaft, a round belt, or any other device for transmitting the power. The motor is a part of the apparatus and is geared direct to the drill. When the base of the drill is secured the arm has a reach of 28 inches, and the machine will drill at one setting over a surface of 56 inches outside diameter and 16 inches inside diameter, just as a regular radial drill would do. The main arm is moved in and out by a screw at the side, and is also rotated about the post by means of a worm and wheel, so that the drill may be set quickly and with precision.

The motor is water and dust proof, and is wound for either a 110 or a 220 volt circuit. The drill has a change of speed for 1-inch or 2-inch drills, a button-ended rod shifting a clutch pin from one pinion



PORTABLE ELECTRIC DRILL.

to the other, and intermediate speeds are obtained by a starting and controlling box placed wherever may be most convenient for the workman. The motor is arranged to run at its normal speed when the drill is doing its heaviest work. The feed is by ratchet and pawl, with a range from .005 inch to .1 inch per revolution. The drawing of the machine shows side and front elevations, with section of main arm, details of the back-gear clutch and variable-speed motion. The machine complete weighs about 700 pounds. It is built by Thomas H. Dallet & Co., Philadelphia.



DETAILS OF DRILL.

A Modern Gun.

No one may say how intimate may be the connection between things apparently very remote. The wagging of a little tail may precede a loud bark, and the wagging and the bark are about as far apart as things can well be located upon the corporation of a dog. So, again, loud thunder is followed by heavy rain; the thunder is high up and the rain is low down—when it gets there. Who shall say, in the dog or in the thunder storm, what relation of cause and effect there may be between the antecedent and the consequent phenomena?

While we are recovering from the dazzle of the Roentgen rays, there comes to us, through a rather triangular source of information—a dispatch from New York to Boston about something in Montreal—an account of a wonderful gun, the invention of a native of the latter city.

It is not necessary to waste a word in glorification of the gun, but just to tell the plain facts about it—as they come to us. To say that it is the most remarkable piece of ordnance in existence, that it will make war impossible and knock into innocuous desuetude our sixteen-inch gun lathe, is all tame enough after we have said that it will throw 259,999 + 1 shots per minute, without any noise or smoke, or any of the things that make noise and smoke—in fact, without any explosion whatever. The dispatch from which we get our information calls the number of shots incredible. We do not find it so at all. We can believe that number as easily as we could believe half the number or double the number. When our credulity gets up to the headway requisite to satisfy the case it is not easily checked.

An inventor cannot be too careful about protecting his invention, and it is rather to be wondered at that in this case so little precaution was taken. We are told that the gun in general appearance resembles a field piece of the modern type. Over the barrel are some cylinders surrounded by a pressure gage. This latter sentence, of course, exposes the true inwardness of the apparatus, and is a most unfortunate one for the inventor. A thing surrounded by water is wet, and if it be hollow or porous becomes full of water. So a gun barrel and its appurtenances surrounded by a pressure gage, and hollow, as we know them to be, become fully saturated with pressure, which, as is well known, is the one essential requisite for the successful stimulation and encouragement of projectiles.

"A little forward of the breech is a funnel, down which the bullets are passed into the gun as fast as two men can pour them." "The mechanism is put into action by simply giving a slight oscillating movement to the trail by means of a lever worked by two men." "How the muscular strength of two men could produce power sufficient to throw 260,000 bullets a minute, with a range of 6,000 yards, is something that the inventor is not yet prepared to explain." To our mind the surrounding of the apparatus by the pressure gage is all the explanation required, and we find confirmation in the fact that the power of the weapon varies greatly with the length of the piece, a two-foot barrel giving a muzzle release of 864 feet per second, while a barrel nine feet long gives the amazing velocity of 3,752 feet. Of course, the greater the length the more will be the pressure.

We may look for wonderful advances in steam engineering when we get the pressure gage to surround the boiler.

A Tube-Cutting Attachment for Upright Drill.

We illustrate a cheap and handy device for cutting off tubing for bicycles. It is an attachment for a common upright drill. The upper box of the frame clasps loosely around the vertical drill spindle, so that the spindle is free to revolve, or to be moved up and down, as required. The base stands on the drill-table, and may be clamped there. The drill chuck takes hold of the short central spindle, which, by means of the bevel gears, drives the horizontal shaft. The cutting disk is in the middle of this shaft, while there is a taper cutter on the left-hand end of it, and a facing mill on the other end, the one taking out the burr on the inner corner of the pipe while the other will face the end perfectly square. The pipe to be cut is supported on hardened steel rollers, which run freely on centers and are immersed in a box of oil. The gage may be set for any length of tube. The four pins on the gage bar at the right are of different diameters, and are used when squaring the ends of the tubing. The tapering cutter unscrews from the horizontal shaft, and upon its removal the shaft may be taken out. This device is made by Perkins & Co., Grand Rapids, Mich.

TUBE-CUTTING ATTACHMENT.

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Letters from Practical Men.

Energy per Candle Power of Electric Lamps.

Editor American Machinist:

In your issue of March 19th, under the head of "Questions and Answers," a correspondent asked for the current required by incandescent and arc lights. The figures given were 15 watts per candle for incandescent and 3 watts for arc lights. I let the matter go, thinking some of the electrical readers would correct same; but as no notice appears in last issue I venture to correct same, thinking it may save the correspondent some trouble. Incandescent lamps vary in efficiency according to the length of life. I use lamps with an efficiency of 3.6 watts per candle, and have burned them over 2,000 hours. Where fuel is high, lamps of 3.1 watts per candle are desirable, the gain in fuel compensating their shorter life. Already one company guarantees a 2.5 watt lamp for 400 hours' life, and I have used lamps on the circuit here of 2.6 watts efficiency. These latter were, however, of high candle-power, viz., 200.

An arc lamp gives an efficiency of $\frac{8}{10}$ of a watt per candle, or $\frac{1}{10}$ of amount stated in the communication. I use a great many arc lamps on this circuit, connecting two in series across the terminals of a 110-volt incandescent system. A resistance box cuts down the voltage to 90 volts, or 45 volts for each lamp terminal. 8½ amperes give a 1,200 candle-power lamp; 8½ x 45 = 362.5 watts per lamp; dividing by 1,200 would give practically .3 watt per candle. On constant current arc-light systems, lamps for street use are generally about 2,000 candle-power and require practically ¾ horse-power (electrical).

Mr. Tecumseh Swift spoke of putting resin in the ladle just before pouring babbitt into a damp place. I am afraid if he depended on the resin alone he would say something beside dam(p). I have seen a box babbitted which was not only damp, but had water standing in it in small recesses where it could not be reached. The plan used was a simple one. Pour ordinary kerosene oil into the bearing, and don't be afraid of getting too much. Then pour as if it were a dry joint, and the result will surprise you.

GEO. E. HOWARD.

[The reply to our correspondent was taken from a standard work of reference, and without going into the subject further. It is obviously wrong. Mr. Bullock's article on "Testing Lamps," in our issue of January 2d, gave results for incandescent lamps ranging between 2.44 and 9.8 watts per candle power—the latter figure being exceptional and for an old lamp. The candle-powers of arc lamps as usually given are purely nominal, and are obtained only by measuring under the most favorable conditions for the test. Under any fair measurement their candle-powers are much less, and the energy per candle-power correspondingly greater than that obtained by using the commercial rating.—Ed.]

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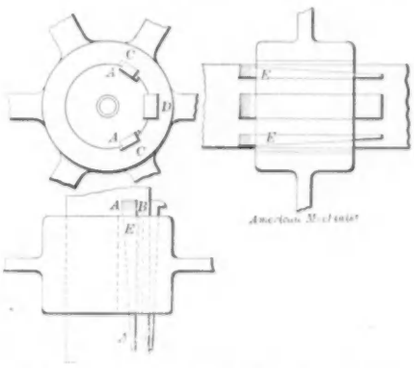
Fastening a Heavy Fly-Wheel.

Editor American Machinist:

In the "American Machinist" of February 27th, is an article on "Fastening Fly-Wheels." As I have had some experience in that line, it may be of interest.

When rolling mills changed from rolling iron to rolling steel, without making any change in their motive power, nearly all the mills met with the same experience that I did—loose fly-wheels. In our mill we had two large fly-wheels—one 40 tons, the other 28 tons—both of which came loose, and this at a time when orders were rushing and we could not stop to fix it right. We kept running by close watching, and in spite of all I would do, the wheels would come loose; I had to put in a new key at least once a month for eight months before the change was made.

I inclose an exaggerated sketch showing position of keys after the change. I will mention that the 40-ton wheel had worn



FASTENING A HEAVY FLY-WHEEL.

itself ⅛ inch loose on the shaft. It is now several years since the wheels have been fixed, and they show no sign of coming loose. You will notice that the wheels

have been fixed proof against backing (which is very necessary in a rolling mill) as well as going ahead.

Now, as to the proportion of sunk keys, the size and depth to which they should be sunk in the shaft and in the boss of the wheel are governed by the diameter of the shaft, but are not in simple proportion to the diameter. For ordinary keys the sides are made parallel, and the thickness must be made a uniform taper ⅛ inch in a foot of length, and the same taper must be given to the key seats in the boss of the wheel:

Let D = diameter of shaft in inches;
B = breadth of key in inches;
T = thickness of key in inches;
d = depth to be sunk in shaft, measured at side of key;
d^1 = depth sunk in the boss of wheel, measured at side of key.

Then $B = \frac{D}{4} + .125$, $T = \frac{D}{11} + .16$, $d = \frac{D}{40} + .075$, $d^1 = T - d$.

Example—Find proportions of a key for a shaft 2 inches diameter:

$B = \frac{D}{4} + .125 = \frac{2}{4} + .125 = .625 =$ breadth of key;

$T = \frac{D}{11} + .16 = \frac{2}{11} + .16 = .341 =$ thickness of key;

$d = \frac{D}{40} + 075 = \frac{2}{40} + .075 = .125 =$ depth in shaft;

$d^1 = T - d = .341 - .125 = .216 =$ depth in boss.

The above is an old formula, and I think no one will ever regret if he strictly adheres to it in laying out keys and keyseats.

GEO. JONES.

Chattanooga, Tenn.

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Keying on Fly-Wheels—Eccentric Piston Rings.

Editor American Machinist:

The letter of your correspondent "Quirk," in your issue of April 2d suggests that I ought, perhaps, to tell my own experience on the same subject:

Happening in the year '60 or '61 to visit the old Novelty Iron Works, I observed the method of securing on the shaft the hubs of the paddle-wheels of the steamship "Adriatic," the last vessel of the Collins Line, which was then receiving her machinery—about which the less said the better. This method, however, which I presume is and was before then common in steamboat practice, struck me as most admirable. It is seen in the following diagram, which shows only the hole through the hub. This, it will be observed, was bored out to the size of the shaft for one-half its circumference, and the keyways were cut on the opposite side. I asked myself, "Why should not this method be adapted for use in the case of all fly-wheels and driving pulleys?" I proceeded to make this adaptation on the first high-speed steam engine that I built,

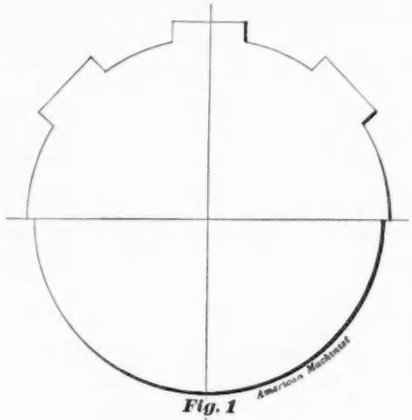

Fig. 1

KEYING ON PADDLE-WHEELS.

and have employed the method ever since, with complete satisfaction.

The following diagram, also showing only the hole in the hub, represents my

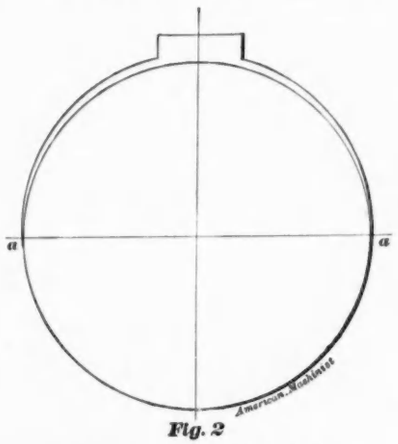

Fig. 2

PORTER-ALLEN FLY-WHEELS.

construction. The wheel is first bored the exact size of the shaft, as for a forcing fit. It is then shifted in the lathe a short distance. The precise amount is immaterial; my practice is to shift it about .1 inch. A thin crescent is then bored out of one side, the points extending a little more than half-way around, terminating at *a a*. The diagram shows the hole as first bored, and also the enlargement and keyway. The wheel is then put on the shaft very easily; in fact, it is rattled on. When the key is driven, it is brought to a perfect bearing nearly half-way around, and the face runs perfectly true. It is also very easily taken off. The method is such a simple and excellent one that I think every engine builder ought to know it and use it.

I had funny experiences with it, though, sometimes, when parties erected the engine for themselves. I remember that before the Westinghouse Co. had brought out their own engine, I furnished a Porter-Allen engine for their first shops in Pittsburgh. A telegram came one day from their superintendent, as follows: "The hole in your fly-wheel is oval; what shall we do about it?" I replied: "Put the wheel on the shaft and drive in the key." Another party, equally horrified at my apparently shocking work, thought that he knew what to do about it without asking any questions. So he set the shaft in the middle of the ellipse, and fitted on each side thin pieces of iron carefully scarfed down to feather edges so as to exactly fill the windage. Then, to his increased disgust, the key would not enter its seat; so he reduced its thickness until it would, and drive up all right. When he started the engine, his fury knew no bounds, as he saw the face of the wheel running about a sixteenth of an inch out of truth. Then he wrote me a letter containing some complimentary expressions, which I should have been sorry to have deserved, and which would not look well in print. In subsequent cases I sent an explanation of this novelty.

By the way, in the same issue Mr. Harris Tabor gives, or seems to give, the credit to Mr. Westinghouse of originating the eccentric packing ring. I suppose if I have any objection to this I should speak now, or forever after hold my peace; so I take this occasion to say that somewhere about thirty years ago I introduced these rings in the pistons of the Porter-Allen engines, substituting them in place of the Ramsbottom rings, which had proved a failure, and making them to work in the same grooves; and they have been used in those engines ever since. I have always supposed that this was the first use of these rings, but am careful, after some recent experience, about claiming anything to be new. So far as I am concerned, however, the idea of such a ring was new with me. Mr. Westinghouse will, I presume, if asked, cheerfully state where he got it.

CHAS. T. PORTER.

[Will Mr. Porter kindly tell us how the keys were fitted in his fly-wheels, and how much dependence was placed upon the sides of the key for driving.—Ed.]

▲ ▲ ▲

Reversed Momentum.

Editor American Machinist:

On a certain occasion I had the pleasure of hearing a lecture on Momentum delivered by a gentleman to a youth in a railway train. The lecturer explained that in the event of a collision the passengers would be shot forward in the direction in which the train had just been moving. Our train was then approaching a station. The gentleman stood up facing the engine, with one arm extended in front of him to break the shock of his forward fall. The train stopped abruptly, but the lecturer was at once shot back upon the seat from which he had just risen. Doubled in two, with his arm still extended and with a look of blank amazement on his face, his appearance was certainly im-

pressive, though not perhaps in a way that he desired.

Next time I was in a train the same result followed my experimenting, and since then I have often observed that a row of standing passengers will always fall backward, and not forward, when a train stops at a station. In this matter they act with perfect unanimity and promptitude.

Why this should be so is not at first self-evident. It may be due to the temperament of John Bull, who does not like to move on faster than he can help; but if go-ahead Americans care to let themselves be knocked about in a railway train for the sake of science, and the same result should follow, then some other reason must be sought. I do not here offer any theory, but simply leave the matter as it is for verification first and explanation afterwards. Of course, I have a theory, but it would be premature to disclose its profound depths at this stage.

I write to America because I once asked a Brummagem philosopher about it. After deeply pondering he said that there were certain mysteries that no man could fathom, and he hinted that it savored of impiety to look too deeply into what was, no doubt, wisely hidden from view.

"For instance," he said, "when you row a boat, you have a lever in the oar; now, where is the fulcrum?" I promptly answered, "At the rowlock." "But the boat is propelled by the pressure on the rowlock; therefore the load is there, and the fulcrum must be at the end of the oar." He urged that the yielding of the water to the oar was a purely accidental circumstance, and that if the end of the oar engaged in a series of notches in some unyielding substance, the fulcrum would then undeniably be at the end of the oar and not at the rowlock.

To this I agreed, and acknowledged my previous error. Then he shifted his ground and said that, as a matter of fact, the water was not unyielding, and that by imagining a case that did not exist I had evaded the point at issue. "For," said he, "work is done in driving the water astern; the end of the oar does that work, therefore the fulcrum must be at the rowlock."

Then he let himself loose and showed that, though the rowlock pushed on the boat, this result was only a reaction from the load at the end of the oar, and that the movement of the boat did not prevent the rowlock from being the fulcrum. It was in vain that I tried to pacify him by agreeing with him, for he shifted about the fulcrum and the load till everything was in confusion. When I was fairly in a fog, he said triumphantly: "Now, when you explain my problem about the leverage of an oar, I will explain yours about momentum acting the wrong way in a railway train."

As I was making for the door he stopped me, and began to say something about where the power was that impelled the rowing boat forward. I heard something about the power moving along with the fulcrum as being a contradiction in terms, about the backward pressure on the footboard, and about the effect of sliding seats; but even a worm will turn:

"Old man," I said, "you know all about mechanical laws, don't you?" He smiled affably, though rather inconsistently with his previous utterances. "Well, you can't have work done without motion?" He nodded. "A weight hangs motionless at the end of a vertical rod. There is no work done there?" "Certainly not," he answered cheerfully. "Exchange the rod for a human arm, and after a certain time the muscles of that arm will be as much exhausted as if the severest work had been performed. Can you explain how that harmonizes with the idea that motion must always accompany work?"

The philosopher shut his eyes, as was his wont, in order to think. When he opened them I had gone, and was hasting away to write to the "American Machinist" for information which I was unable to gain on this side of the Atlantic.

W. A. CARLILE.

[The above is printed just as we received it. It is scarcely necessary to say that we assume no responsibility for its statements or assumptions. It should be remembered that it was written in England.—Ed.]

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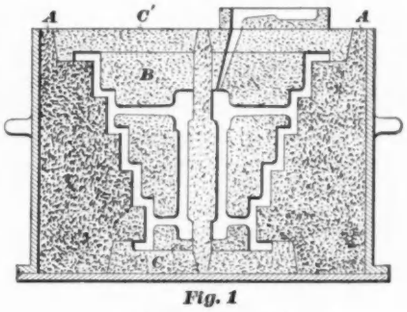


Fig. 1

MOLD COMPLETE.

Molding a Cone Pulley.

Editor American Machinist:

The recent articles on Molding Cone Pulleys recall a method which I think would prove cheaper than any shown. Having been called upon to make patterns for a cone pulley, I worked out the method shown in Figs. 1, 2 and 3, and as it is considerably different from any I have ever seen in use or described, I send it in on the chance that it may be new to some.

Fig. 1 is a section of flask and mold complete, and ready to pour; *A* is the green sand mold, *B* the main core, and *C C*[1] the end of cover cores. The pattern is a plain five-step cone, with flange at large end to form setting for core *C*.

The cores *C C*[1] are circular disks recessed to form the cone flanges. After ramming to near top of small step of cone (cone being small end up at this stage), an iron ring, loosely fitting small step, and of same thickness as flange, is pressed down until flush with top of cone. This forms seat for C_1 which is then put in place; and

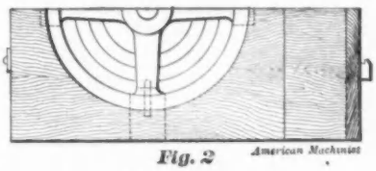


Fig. 2

CORE BOX.

after finishing ramming, the bottom plate is clamped on and flask turned over.

The main core *B* is made in halves in the box, Figs. 2 and 3; Fig. 2 being end elevation with front open, and Fig. 3 the plan view. It is rammed with everything, as shown in the plan view; then the hub pattern with pulley arms attached, as shown, is pulled. After turning over, the hinged front is opened, and a few light taps with a mallet loosen the core. By using the hinged front, taper or "draft" is avoided, and the half core may be vented before the removal of the pattern; that is, vented from the end, if that is the method to be adopted.

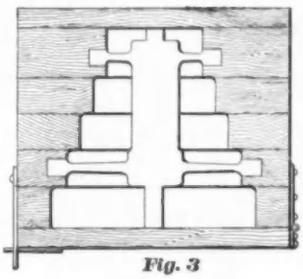


Fig. 3

CORE BOX.

The other features are so clearly shown that description is unnecessary, further than to say that the arms are of elliptical cross-section. Pattern work and molding, it will be noticed, are of the plainest kind.

OTTO E. EVANS.

York, Neb.

▲ ▲ ▲

The Differential Disk Regulator.

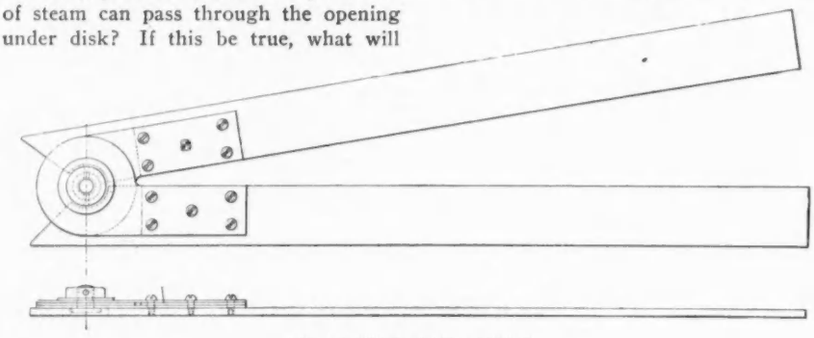
Editor American Machinist:

The Holly reducing valve, described in your issue of March 19th, is, as one of the closing paragraphs says, "a most interesting subject." But, to my mind, the article does not fully and satisfactorily explain the operation of the valve, and I hope Mr. Holly will, through your columns, more definitely do so. A valve so simply accomplishing an operation that others have encumbered with complex mechanism—that is, in fact, a revolution—certainly deserves further notice.

I will mention some points that are, to me, not clear. The reduction to, and control of, the terminal pressure, is said to be accomplished by the difference in areas of the steam opening under the disk, that on and the upper side of disk. This difference in areas, as I understand, is pro-

portioned according to the reduction of pressure desired, and that every different reduction requires a differently designed valve.

Now, the area of the opening under the disk limits the surface of under side of disk exposed to the high-pressure steam only so long as the valve remains closed. As soon as the disk leaves its seat, the exposed areas of the upper and under sides of the disk are approximately equal. And is not the under side exposed to the higher pressure, and will not the disk have a tendency to rise until the pressures on both sides are equal (neglecting the weight of the valve and—an opposing element—the deflection of the steam under the disk), provided the necessary amount of steam can pass through the opening under disk? If this be true, what will



AN ADJUSTABLE ANGLE.

again seat the disk except its own weight?

Then, again, what is the function of the threaded stem passing through the bottom stuffing box? As shown in Figs. 4 and 5, its manipulation could only allow or prevent the disk seating itself—and why this? But in at least some of the Holly valves this adjusting screw exists on the top, much the same as on the ordinary globe valve, except that its lower collar has vertical play in socket on top of disk; so that its adjustment limits the lift of disk, but does not prevent its seating.

Near the top of third column, page 2, Mr. Holly says: "It is a fact that this valve holds a proportional amount of the initial pressure," etc. Does not the same phenomenon occur when a steam passage is contracted by any means; i. e., will not the amount of steam passing through such opening to a certain extent be dependent upon the difference in pressures existing on the initial and terminal sides? But in the Holly system of steam reduction this defect is apparently corrected by the use of a compound valve, shown in Fig. 5. What will be the difference between the result secured by the use of this valve and that attained by placing two ordinary globe or gate valves in a line of piping, and properly adjusting them so as to have in the three divisions thus formed, respectively, the initial, an intermediate and the terminal pressure?

The Holly valve undoubtedly accomplishes a reduction of pressure, and may automatically control that on the terminal side; but I think clearer reasons should be given for its so doing than those in the article herein referred to.

HAMILTON.

▲ ▲ ▲

Instead of a Third Triangle.

Editor American Machinist:

Having read the articles in your recent issues on the Third Triangle and Dividing the Circle, I would like to add the following:

I have been at the board long enough to think I know some of the "tricks of the trade," but am still on the lookout for new ones that will shorten the time between the two ends of a job. In following this third triangle scheme, as expounded by your various contributors, I have gained an idea or two; and now, as the Frenchman says, "I would like to reciprocate:"

For more than ten years I have used a third triangle, and it has often helped me to a feeling of satisfaction in the time I have spent on a piece of work—not that I have ever completed a drawing as soon as the foreman or superintendent expected, or entirely satisfied an inventor in the time it took me to work out his ideas. No, I have never done that; and if there is anyone among your readers that has, I would very much like to hear how and by what means, instrumental or mental, it was accomplished.

My third triangle will be readily understood from the accompanying sketch, which it materially aided in constructing (worked a sort of X-ray business on itself). Its excuse for existence is that it will do what a swivel-headed T-square pretends to do—allow you to work at any and all angles anywhere on your board; and as for transferring an angle from one drawing to another, it will do it just as nice as a compass will draw a circle. It will not divide circles; and I want to say right here that I do not think a triangle is the proper tool for that. I have a better one; but that is another story, as someone else would say.

The construction of my third triangle needs little explanation, as the accompanying sketch is accurate in every particular. The arms should be of hard wood; the joint is a split one, similar to those used in drawing instruments, and is made of 1-32-inch steel—three pieces just alike, and two others to make up thickness where required. This joint made as shown will be smooth in action, and will retain its stiffness, when once set, indefinitely. It should be set so that it may be easily adjusted to any angle, yet have sufficient friction to resist ordinary handling. It can be made at a trifling cost by anyone; and while it will not divide the circle into seventy-two parts, it will materially aid in laying out angular work.

W. T. DONNELLY, M. E.

New York City.

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Some Useful Constants.

Editor American Machinist:

There are several other multipliers besides Foote's constant that I suppose are not in general use, and that may be of value to many of your readers. I have used them for several years and found them very helpful in making calculations, but it did not occur to me that others might not pick them up the same as I had until I read Mr. Geo. B. Foote's communication.

In making mechanical horse-power calculations,

$$\frac{a}{33000} = a \times .000030303.$$

My note says: "Multiply by 303 and point off seven decimals for multiplier." This is close enough for ordinary work, but if it is required to be very accurate, use the full set and point off nine decimals for multiplier, which will show an error of only $\frac{2}{1000}$ of 1 horse-power in calculations involving 2,000 horse-power.

For electrical horse-power,

$$\frac{a}{746} = a \times .0013405$$

For ordinary calculations, multiply by 134 and point off five decimals.

$$\frac{a}{360} = a \times .0027778$$

$$\frac{d \times 3.141}{12} = d \times .2607 \text{ in inches}$$

thus getting circumference in feet from diameter in inches by a simple multiplication.

For getting horse-power of belt, I use formula,

$$\frac{d \times R \times W}{3050} = \text{H. P. when } \begin{cases} d = \text{dia. pulley in in.} \\ R = \text{rev. per min.} \\ W = \text{width belt in in.} \end{cases}$$

Take for an example a 35-inch pulley, 174 revolutions, 6-inch belt. In the ordinary way this would read:

$$\frac{35 \times 3.141 \times 174 \times 6}{12 \times 800} = 11.955 +$$

Using my formula, it would read:

$$\frac{35 \times 174 \times 6}{3050} = 11.982 +$$

As there are a number of ciphers and the same figure is repeated several times in these multipliers, the operations become very simple. In making estimates and calculations on small work, my rule for the weight of metals will be found convenient: Multiply the area in inches by the thickness in thousandths of an inch,

and the product by 31; the result will be number of pounds required to make 100 duplicates. Example: Find the amount of brass, No. 28 Brown & Sharpe gage, it will take to cut 100 blanks $2\frac{1}{4} \times \frac{9}{16}$:

No. 28 B. & S. gage = .013

$2\frac{1}{4} \times \frac{9}{16} \times .013 \times 31 = .49+$

or, practically, ½ pound per 100 blanks.

One hundred duplicates of brass rod or wire can be found by multiplying sectional area by the length, and product by 31.

Other metals can be calculated by multiplying weight of brass by a constant representing the value of such metal in pounds in brass. The following table gives such constants for metals most in use:

Metal.	Multiplier.
Brass	1.00
Wrought iron	.94
Soft steel	.94
Copper	1.08
Lead	1.38
Zinc	.875
Aluminum	.322

GEO. E. TERRELL.

Waterbury, Conn.

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A Protractor Triangle.

Editor American Machinist:

Noting the recent communications regarding the advisability of a third triangle for draftsmen, and the proposed panacea of a B. & S. protractor, reminds me that steel ruling edges are not very popular, for the reason that they always soil the paper, and are heavy and cold, and are therefore unpleasant to the touch, and that the B. & S. protractor, aside from its superior finish, must be set to the desired angle, the same as any other protractor.

Apropos of triangles with special angles, I inclose a sketch of an 8-inch celluloid triangle graduated on the underside, made by me about a year ago. This is, of course, an elaboration of the well-known Kelsey triangle, and the sketch shows its adaptability for some everyday requirements, such as showing screw threads, wire springs and V-slides; and with the protractor lines extending out to the 30-degree and 60-degree ruling edges, any desired angle whatever may be drawn directly without first pointing off, and at the same time lines may also be directly drawn at right angles. There can be no question but that drafting tools are crude, and have undergone but little improvement, and that the introduction of celluloid is probably the best step forward of recent years in this direction.

C. H. MCCLELLAN.

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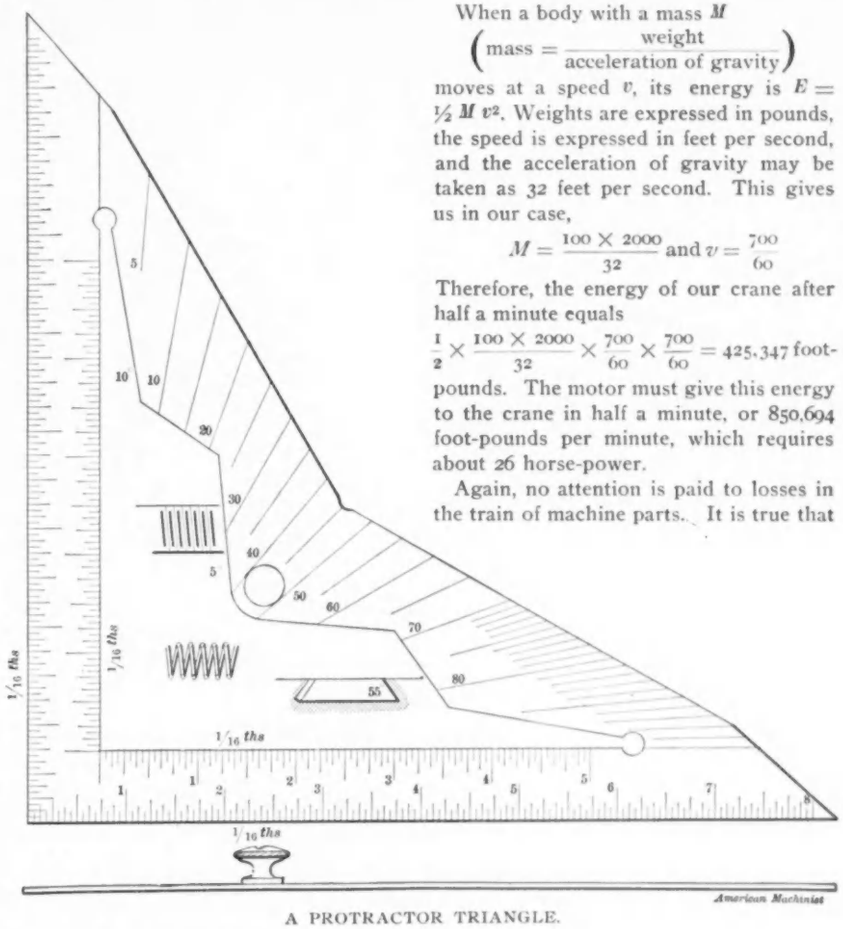
"Power Calculation for a Traveling Crane."

Editor American Machinist:

I read with great interest an article, under the above title, appearing in the "American Machinist" of April 2, 1896. Mr. Chas. L. Griffin, the author, used, however, one expression which should be taken with great caution. He says: "As a matter of fact, it is found in practice that any motor which will stand its running load, without injury, will stand the extra effort which must be exerted for a few seconds in starting under the same load." If a builder of traveling cranes were to apply this principle to a crane which has to run at high speed, he would find to his dismay that the fact as quoted is no fact at all. This is only true where the crane runs at low speed and the motor has an ample margin of power. Let me illustrate this with some figures taken from actual practice:



A PROTRACTOR TRIANGLE.

A crane of which the total weight was 100 tons was required to travel at the rate of 700 feet per minute and to get up full speed in half a minute. Taking 25 pounds per ton as the required horizontal effort, the total pull is $100 \times 25 = 2{,}500$ pounds. With the crane at speed, this force moves with a speed of 700 feet per minute; therefore, the number of foot-pounds per minute necessary to move the crane at this speed is $700 \times 2.500 = 1{,}750{,}000$. As 33,000 foot-pounds per minute is one horse-power, the number of horse-power necessary to keep the crane moving is

$$\frac{1750000}{33000} = 53$$

No margin is allowed for losses by friction in gearing, shafting, etc.

When a body with a mass M $\left(\text{mass} = \frac{\text{weight}}{\text{acceleration of gravity}}\right)$ moves at a speed v, its energy is $E = \frac{1}{2} M v^2$. Weights are expressed in pounds, the speed is expressed in feet per second, and the acceleration of gravity may be taken as 32 feet per second. This gives us in our case,

$$M = \frac{100 \times 2000}{32} \text{ and } v = \frac{700}{60}$$

Therefore, the energy of our crane after half a minute equals

$$\frac{1}{2} \times \frac{100 \times 2000}{32} \times \frac{700}{60} \times \frac{700}{60} = 425{,}347 \text{ foot-pounds.}$$

The motor must give this energy to the crane in half a minute, or 850,694 foot-pounds per minute, which requires about 26 horse-power.

Again, no attention is paid to losses in the train of machine parts. It is true that part of the available 53 horse-power may be used to give the crane this energy, as the crane during the first thirty seconds does not require the full power to keep it in motion; but, whether the crane travels fast or slow, the horizontal effort remains the same, and very few motors are able to work for half a minute with an overload of 50 per cent. In the case from which my figures are taken this was proved very conclusively, as the crane refused to move, or, if it moved at all, it did so at the cost of an armature. When a 60 horse-power motor took the place of a 50 horse-power motor, the trouble ceased to exist.

The formula $E = \frac{1}{2} M v^2$ shows that the energy imparted to the crane (and hence the horse-power) is proportional to the square of the velocity. If, therefore, this crane were expected to travel at the rate of 100 feet per minute,

$$\left(\frac{100}{700}\right)^2 \times 26 \text{ horse-power}$$

would have been sufficient to get up speed in half a minute:

$$\left(\frac{100}{700}\right)^2 \times 26 = \text{about } \tfrac{1}{4} \text{ horse-power.}$$

Though a speed of 700 feet per minute is unusually high for a traveling crane, cases of this kind have presented themselves, and it is well to be prepared for them.

A. L. DELEEUW.

[It strikes us that our correspondent's

statement that part of the 53 horse-power required for bridge travel at full speed is available during the starting of the bridge, is liable to misapprehension. With an independent motor connected positively to each gear of the crane, the speed of the motor varies with that of the bridge, and the reduced demand for power at slow speeds is accompanied with reduced capacity of the motor. It is really a matter of pull rather than power, and if, after the instant of starting, the acceleration of the bridge is constant until speed is reached, the total pull, being the sum of that due to the acceleration and that due to the frictional resistance of the bridge, will be practically constant. This calls for a constant torque by the motor until speed is reached, when the torque for the acceleration of the bridge will drop off. At the instant of starting, a greater pull and torque must, of course, be developed to overcome the friction of rest.—Ed.]

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An Ingenious Pump.

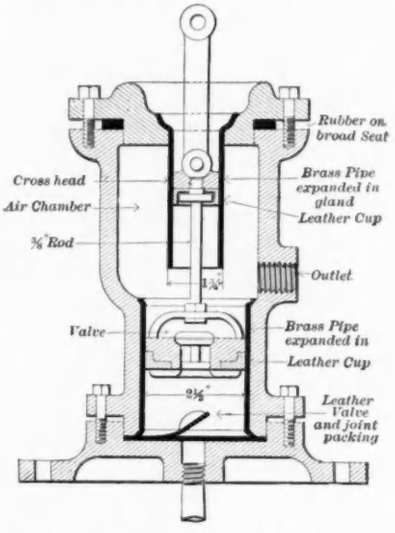
Editor American Machinist:

The pump shown on page 318 (which we may call A) is so good an illustration of designing on the one-idea-at-a-time-plan, that it will be profitable to compare it with another pump (which we may call B), designed on a plan comprehensive enough to reach from the pig-iron pile to the paint shop. From this comparison we may come to know how A works, and the proper name for it:

In A, each piece serves a purpose, and each purpose requires a piece—the result being a multiplicity of parts, a costly construction, and trouble when making repairs.

In B, each piece serves two or more purposes; the joints are reduced to two, and every part is get-at-able by removing five bolts. The construction is so easy that it can be done thoroughly and cheaply, and it is done thoroughly. B is largely used for spraying fruit trees. As the "medicine" is corrosive to iron, some brass is used. The body, of cast iron, serves for the support of the details, for part of the chamber for the liquid, and for one side of the air chamber. The large opening at the upper end (for the removal of the large piston) is closed by the gland, which is made to hold the small cylinder. This cylinder forms the other side of the air chamber and the guide for the crosshead. The crosshead is the small piston. The large piston is a valve box. The leather washer for the bottom joint furnishes the valve and valve hinge. The base piece is valve seat, attachment for suction pipe, and means for fixing to any foundation. The lever (not shown in the rough sketch) stops on the gland on the down stroke, and on the base of the pump on the up stroke. Every detail has been so thoroughly considered that improvement seems impossible, either in design, construction, or use.

The two pumps reach the same result, in use, but in a different way. The large piston rod, in *A*, does no displacing. As the big end of this "plunger" moves both



ways into separate chambers, the pump is double-acting. *B* is also double-acting, but as the small piston does do displacing, the large piston makes the down stroke idly. Both are alike in taking the supply, for the two ends of each, from two sources. *A* is a double-acting piston pump, and, except in the one item of taking its supply from two sources, differs in no way from the usual run of double-acting piston pumps, wherein displacement is procured by a piston moved to and fro by a piston rod. Unless we want to call every such pump a differential pump, *A* is not entitled to the distinction.

SUPERANNUATED.

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Running a Cupola All Day—Chills.

Editor American Machinist:

I have been a careful reader of your valuable paper for the past ten years, and still look for it every week. The "Questions and Answers" are quite interesting. There are two answers that, to my mind, do not give the information asked for, namely, the question of how to run a small cupola so that it will melt continuously all day. There is a cupola in this vicinity, 20 inches inside of lining, that is being run every day from 8 A. M. to 4 or 5 P. M. A few oyster shells are thrown in from time to time to help keep it clean, there is no slag hole, the iron is melted hot, and there is no more trouble than is experienced in any foundry. A number of cupolas in this country are being run in the same way.

The other answer is the one relating to the casting of chilled jaws for rock crushers. The only trouble "A. R. I." says he has is that the castings are too soft. Then it is quite plain that the mixture is too soft. I have made chilled crusher jaws for twenty years with fair success. The chills I use are 24 x 18 x 3 inches—they are not finished. The parties who order them require 1 inch chill in them. If "A.R. I." will notice the fracture of the old jaws, or, if they are not broken, take a chisel and chip a piece off so that he can see how deep the chill is, he will know how much chill he will get in the ones he is making. If the chill is not deep enough, add enough No. 4 or No. 5 to make it the required depth; if too deep, add No. 1 enough to make it soft. "Good hard charcoal iron" is, to say the least, rather indefinite. All charcoal iron above No. 2 is hard and, no doubt, good. The iron should be melted hot, swung to place in a ladle that will hold a ton; a smaller ladle may be used, but this amount is easier to handle. Pour at about the same temperature that any other casting would be poured at. It does not make any difference with the depth of chill whether taking the castings off the chills or leaving them on. If the mixture of iron used will not chill the required depth it is too soft, and no matter how thick the chill is made it will not alter it.

FOUNDRYMAN.

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Simple Tests of Oils.

Editor American Machinist:

Will you please give me, through the columns of the "American Machinist," information in regard to cheaply testing the value of different samples of machine and engine oil? In buying oil for a factory, how is it possible, without an expensive laboratory, to determine with reasonable accuracy the value as lubricants of the many samples of oil submitted by enterprising drummers? I do not remember having seen just this subject discussed in your paper. Would like some quick and easy tests which would be better than the common plan of putting it on a bearing and watching to see "how long it will last."

EDMUND MORRIS.

[The following may be taken as a partial answer to the above, although it speaks only of cylinder oils. There is much still requiring to be said upon this topic.—Ed.]:

Editor American Machinist:

Apart from the test for determining compound oils, there appears to be no other except a chemical test, and that is unsatisfactory.

To determine the amount of compounding, take a two-ounce vial and fill it half-full of a very strong alkaline solution—ammonia, caustic soda or caustic potash. Fill the vial nearly full of oil and shake thoroughly. Mineral oil will not make soap and will separate. Any animal or fish oil will mix with the alkali, and from its color can be told the compound and the percentage of the same. Neatsfoot oil will be yellow, but tallow and most other oils will be of different shades approaching

white. Lard oil will be whiter than tallow.

This test will prove sperm oil to be composed of about two-thirds of paraffine oil. Lard oil is similarly adulterated. This test does not show the "stock" from which the oil is made, nor whether the animal acids have been extracted from the animal oils.

A straight mineral oil of high fire test may be used in some simple engines and in the high-pressure cylinder of compound engines. It will not work under all conditions, nor in all cases. It should never be used in the low-pressure cylinder without compounding; and the best for this purpose are tallow, neatsfoot and lard. These should have the acid extracted, which honest oil dealers can now do.

W. E. CRANE.

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Requirements for Admission in Engineering Schools.

Editor American Machinist:

In view of the discussion which is now appearing in the columns of the "American Machinist," the inclosed circular, defining the practice of Purdue University in reference to the admission of apprentices to engineering courses, may be of interest.

W. F. M. Goss.

Purdue University, Lafayette, Ind.

[Following is the substance of the circular referred to above, which will be seen to be very closely in line with our original editorial on this subject.—Ed.]:

"In response to numerous inquiries in regard to the admission of experienced mechanics to the Engineering Courses, it has seemed advisable to make a statement embodying the practice of the University in such cases.

"Purdue University offers courses in Mechanical, Civil and Electrical Engineering. All of these courses include lines of work such as carpentry, pattern-making, molding and casting, forging and machine work, with which shopmen are often familar, and for this reason such men may enter these courses under conditions which are greatly in their favor. Thus those who, as apprentices, have acquired skill in manipulation and have become acquainted with the principles of construction, can properly be excused from the shop work which other students are required to take; the experiences of the shop can in this way be made to count in advancing the student in his professional course. Or if it happens that an applicant is unprepared in some line of work required for admission, such deficiency need not prevent his admission, provided his credits in shop work are sufficient to give him time in which to bring up the required preparatory work.

"Each application for credit for conditional admission will necessarily require individual consideration, and persons seeking such admission are advised to inform themselves by correspondence before going to the expense of applying in person.

"The tuition at Purdue for all residents of the State of Indiana is free. For non-residents the tuition is $100 a year. The trustees have, however, placed a considerable number of scholarships at the disposal of the President of the University to be bestowed upon worthy students at his discretion. The effect of a scholarship is to remit the tuition charge. Candidates for admission living outside the State of Indiana should send their requests to the President."

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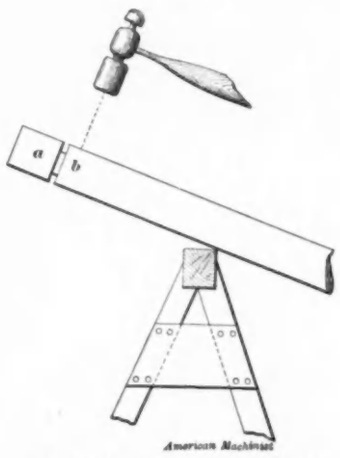

ANOTHER WAY TO BREAK IT.

Breaking Off a Piece.

Editor American Machinist:

I have been a reader of the "American Machinist" for years, and, through its medium, have become acquainted with many well-known and popular mechanics; and although not knowing them personally, there seems to be a latent feeling of friendship which grows stronger as we continue to read the articles they contribute for the promulgation of mechanical principles. Feeling as I do—and I am sure all mechanics will voice the same sentiment—I will kindly ask Mr. Tecumseh Swift a simple question:

In his article of March 5th, "Breaking Off a Piece," he asks, in reference to his sketches, "What is the difference and why?" Now, it certainly is easier to ask a question than to answer one, although it apparently doesn't seem so in this case; but instead of trying to answer, allow me to ask one in return:

I had a long bar of 1½ inch round tool steel of which I had to cut off a piece 1¼ inches long. I did not cut down quite deep enough with the cutting-off or parting tool, and not wanting to put it in the lathe again, I tried to break it off by striking it on the end *a*, as per sketch. After striking it repeatedly with a 1¾-pound hammer, it would not break off. I then held the bar in my hand and gave it a few quick, smart blows at *b*, and the piece dropped off with a clean break.

Now, why was it thus?

JACOB M. STEINHARDT.

Newark, N. J.

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Value of Published Tests of Steam Boilers.

Editor American Machinist:

I wish to utter a remonstrance against the publication of impossible boiler tests in trade catalogs and elsewhere.

For instance, the Clonbrock Boiler Works, Brooklyn, manufacturers of the Morrin climax boiler, claim a test in their catalog, page 37 (of which test I send you a copy), in which they evaporate 14.65 pounds of water from and at 212 degrees, and must consequently attain an efficiency of 97⅔ per cent. Of course, this is simply ridiculous to men in the profession; but those in the office, who have no time to post up on such matters, may be imposed upon sometimes.

Let us analyze this test: The maximum evaporation possible for 1 pound of pure carbon is 15 pounds of water from and at 212 degrees, assuming there is no waste heat; or, in other words, 100 per cent. of the heat generated by the combustion of 1 pound of pure carbon will evaporate 15 pounds of water from and at 212 degrees.

There is no temperature of gases given in this test, neither is the temperature of boiler-room given. We will assume them at 550 degrees and 80 degrees respectively, which I think will readily be conceded as conservative estimates for the boiler tested, and the season of the year—August.

Twenty-four pounds of air are required for each pound of combustible (Box). The specific heat of air is .238, and the heat units gone up chimney per pound of air $550° - 80°$, nearly. Then

$$\frac{24 \times .238 \times (550° - 80°)}{965.7} = 2.78 \text{ lbs. of water}$$

from and at 212 degrees as the minimum loss by chimney. This is a loss of 18.5 per cent., which being deducted from 100 per cent. leaves us 81.5 per cent. There will be a further loss of at least 5 per cent. by radiation, so that we have finally available for evaporative work only 76.5 per cent. of our original pound of carbon, and therefore can evaporate only 76.5 per cent. of 15 pounds, or 11.475 pounds from and at 212 degrees, instead of 14.65 pounds as in the test. This shows the figures of the test to be 3.525 pounds, or 23.5 per cent. higher than it is possible to get under the conditions given and assumed.

I have written the Clonbrock Boiler Works, giving my figures. In reply they said that "they had every confidence in the people making the test, and thought it must be correct," and advised me to write the Baltimore Electric Light people, which I did about a year ago, giving my figures, and asking them if they tested the quality of their steam, and also if they

knew their blow-off valve was tight; but as yet I have not heard from them in reply.

A few days since the agent for a new boiler furnace having quite a run through the country called upon us, showing a test, with red ink very much in evidence, but when subjected to analysis it was 11½ per cent. too high.

Test of One Climax Boiler, made at the Brush Electric Co., Baltimore, Md., by Mr. E. F. Baker, General Manager, Baltimore, August 12, 1891.

Rated capacity, 500 horse-power.

Duration of test, 8:15 P. M. to 6:15 A. M., 10 hours.

Kind of fuel used, Cumberland.

Average steam pressure, 96.4 pounds.

Temperature of steam, 336 degrees.

Average temperature of feed-water, 152 degrees.

Pounds of coal burned, 20,064 pounds.

Pounds of refuse (ash), 3,161 pounds.

Pounds of combustible, 16,903 pounds.

Percentage of ash, 15.7 per cent.

Total water evaporated, actual conditions, 224,461 pounds.

Total water evaporated from and at 212 degrees, 247,366 pounds.

Horse-power developed, actual conditions, per hour, 748.2 horse-power.

Horse-power developed from and at 212 degrees, 824.5 horse-power.

Water evaporated per pound coal, actual conditions, 11.18 pounds.

Water evaporated from and at 212 degrees, 12.32 pounds.

Water evaporated per pound of combustible, actual conditions, 13.3 pounds.

Water evaporated per pound of combustible from and at 212 degrees, 14.65 pounds.

Percentage overrated capacity, actual conditions, 49.6 per cent.

Percentage overrated capacity from and at 212 degrees, 64.8 per cent.

Draught in stack, 2-10.

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Resin and Water and Melted Lead.

Editor American Machinist:

Mr. Swift seems to be a doubting Tecumseh as to the efficacy of resin in preventing hot lead from flying by coming in contact with moisture when pouring joints, but the writer is not ashamed to subscribe to the great benefit to be derived from its use in such cases. I well know the usual result with hot lead and water mixtures, and have beguiled many a wasted hour dissecting the glistening particles from my doeskin pants.

In the plant of which I have charge there are some two miles of cast-iron water pipe from 6 to 12 inches, and connections have sometimes to be made where it is almost impossible to get the joint dry. An old water-works man was the first I ever saw use resin in a wet joint, and the writer had so little faith in the result that he secured a good sheltered position just previous to the expected blow-out that did not happen. There was water in the pipe, and it had showed itself in the bell even after the oakum had been driven. The water-works man did not put a lump of resin into the ladle, but he threw half a cup full into the "dam" of the "snake," and then poured the lead just as if he wasn't afraid. There was no undue upheaval and the joint was a good one. This was a number of years ago, and men under my direction have done the same thing scores of times since and without the loss of an eyebrow. Another man of experience tells me that kerosene oil is nearly as good for the purpose as resin.

PETER H. BULLOCK.

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Micrometer for Caliper Points.

Editor American Machinist:

Inclosed herewith please find rough—very—tracing of a pair of outside calipers, which may interest some of your readers.

I converted a pair of ordinary 15-inch calipers to this form, and find them very handy and susceptible of easy and accurate adjustment. With a screw of, say, 50 threads per inch, and head divided into 20 equal parts, each part aligned to the knife-edge projection on leg would indicate $\frac{1}{1000}$ of an inch, making them micrometers of wide range, and of sufficiently cheap form to be within the range of every machinist's pocketbook.

J. W. PAYLER.

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Box-Frame Presses and Globe-End Connecting Rods.

Editor American Machinist:

I am much in doubt as to the soundness of Mr. Oberlin Smith's claim to have been the first to use the box or hollow pillar frame for punching machines or power presses. I believe there are examples of English design much earlier than his work.

As to the globe-end rod which Mr. Oberlin Smith claims to have broadly covered by patent in 1886, I would say that the globe-end rod was in common use in many places in 1881, and was first introduced to my notice in 1881 by the late Edmund P. Jorden, at that time superintendent for E. W. Bliss, of Brooklyn. Mr. Jorden told me it was well known in Waterbury, Conn., for a very long time previous. I think it is very old.

It is to be noted that this box design, unpatented as it is, has not been generally adopted by press-makers, although ten or twelve years before the public. I believe it to be, however, much superior for press frames to the ribbed form, as this frame of a press is constantly subject to severe torsion strains, which are much better resisted by the box form than by any possible ribbed distribution of metal.

JOHN RANDOL.

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Filing Drawings and Tracings.

Editor American Machinist:

There seems at present to be considerable discussion in the "American Machinist," about the proper method of filing tracings. There are always two sides to a question—and in this one perhaps more.

Mr. Randol certainly expressed Mr. Carman's ideas in his article descriptive of the Gates Iron Works drawing-room, which, no doubt, in Mr. Carman's mind, perfectly meets his requirements. On the other hand, Mr. Chase seems to think Mr. Carman's ideas are all wrong and his just right. Now, I think they are both right, for the reason that I use both methods—not exactly as Mr. Carman files them, in tubes, for that is a new idea to me, and I should say a good one in many cases. I should favor his method in this way: Where tracings or drawings are seldom used after the first time, I advocate rolling up and filing away in a suitable place, where they will not be handled every time others are, that are in constant use. The ones that are used frequently I keep in drawers, after Mr. Chase's idea, a record of all drawings, tracings and blueprints being kept in an indexed book, so a moment's glance will reveal the location of the drawing desired. I do not claim this method is superior to any other in existence, but it meets my requirements, and I know there is no large waste of time in looking for drawings; so why should not others be satisfied if I am?

I also wish to say a few words in regard to location of drafting rooms. It is conceded by nearly all draftsmen and artists generally that a north light is superior to any other Allowing that this is so, I prefer the south side of a building in this climate, in preference to the north side, for the following reasons: In the winter it is well known among heating engineers that the north side of a building is most difficult to warm. Furthermore, the wind is usually from the northward, and a drafting room should be well supplied with windows, which, owing to changes in the weather, are impossible to keep tight. Consequently, there are many days during the winter when a draftsman devotes more time to rubbing his fingers, and

walking around to keep warm, than is actually given to work. During the summer months the direction of the winds is generally just the reverse from winter, and a light breeze suffices to dry the perspiring hands, which would otherwise soon soil a nice drawing, the breeze also adding much to the draftsman's comfort and peace of mind.

J. G. KINGSBURY.

Bridgeport, Ct.

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Making Castings on a Chill.

Editor American Machinist:

The chill should be at least 5½ inches thick. The thickness of the chill has nothing to do with making a chilled jaw perfect. Of course, the chill helps to chill the jaw, and gives the casting the form of corrugation required. The chill must be smooth; that is, the chill casting must be made to conform with the jaw. Prepare your mold by putting a small quantity of lard oil on the chill, and apply good black-lead; a light coat is sufficient. The cope should be made of iron and rammed up on the nowel with core sand. Swab it well with molasses, and put it in the oven to dry. When dry, put it in and pour, using good large runners, as the first hard iron put on the chill must be poured dull. It should be poured with two ladles, one at each end.

To charge the cupola for a 325 to 400-pound jaw, put in 300 pounds hard iron (plow points are good, or hard moldboards) on top of first charge of fuel. Put the hard iron in even; on top of it put about 50 pounds of coke, and then good soft machinery iron, as pulleys, and stop up the cupola. After tapping out enough hard iron to fill the jaw mold 2½ to 2¾ inches above the chill, tap out and pour the soft iron on top of the hard. You should wait six to ten minutes after pouring the hard iron, before pouring the soft. Have the mold well secured, pour the soft iron quick, and let flow through 35 or more pounds. To prevent the chill from cracking, and the casting becoming crooked, the casting should be removed from the chill and left standing on the edge, leaving chilled side exposed. It should be chilled ¾ inch deep.

This formula is for making one or two jaws per day in a 24-inch cupola. If "A. R. J." has two cupolas, he can make as many as he wants at each heat by running both stacks at once. Good judgment in selecting the hard iron is required. The bed of coke must be even, and the hard-iron scrap broken up in pieces of uniform size, and put in even also. A jaw made of all hard iron is not as good as one made of soft and hard together, as by making the top of the jaw soft it can be planed. A jaw made in this way, and put into the stone-crusher frame with a sole leather or thick lead gasket, ought to do 12 or 15 days' work.

HARD IRON.

Talc for Tracing Cloth.

Editor American Machinist:

I have read with considerable interest the discussion and suggestions in the "American Machinist" regarding the use of French chalk, or, as you call it, "iron-worker's crayon," which is nothing more nor less than common talc, as I understand it.

I feel some pangs of conscience smiting me because I did not bring the many and beneficent uses of this substance to the notice of your readers years ago; for as many as five or six years ago, when I was a draftsman in the employ of the Corliss Steam Engine Works in this city, we all used this talc there for the purpose you have specified, and we obtained our supply from the superintendent of the boiler shop, who had used it for a long time previously. If a draftsman wishes to remove the excessive gloss on tracing cloth, there is no better means of doing it than scraping a little of this French chalk off upon the cloth and rubbing the surface with the powder thus obtained. It is cleaner than ordinary chalk and much better.

J. P. WILLIAMS.

Providence, R. I.

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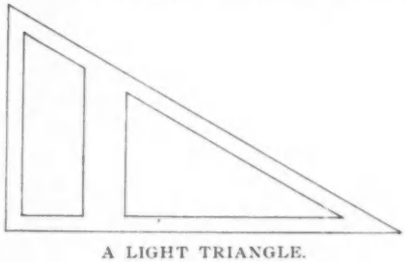
Triangles and Squares.

Editor American Machinist:

Speaking of triangles reminds me of one or two features that I employed in making some steel triangles. One is shown in the figure, and consists of a bar



A LIGHT TRIANGLE.

across the large triangle, about four inches from the bottom. It is intended as a support for the fingers in holding the triangle or moving it about. It also permits the sides to be made narrower and thicker. They are usually made too thin for every-day use. I tried the experiment of browning them by a process similar to that employed on gun-barrels, to make them less trying to the eyes than nickel-plated work. It is a success if they can be browned on one side only, and always used that side up; but it soon wears off on the bottom side.

I also made a rolling parallel ruler of steel, and browned it in the same manner. That is a decided success.

I made a T-square of steel, and had the blade tempered by the saw-maker to prevent kinking. The head is made of a piece of saw-steel about ⅛ inch thick, with the front edge bent down at right angles about ¾ inch for a bearing against the edge of the drawing-board.

WILLIS WHITED.

Our monitor or turret lathe is in England the "capstan" lathe. At the March meeting of the Birmingham Association of Mechanical Engineers, a paper was read by Mr. A. Calvert upon the construction and utility of this lathe. The author stated that, while the Americans claimed to be the inventors of this up-to-date tool, it was in use in Government factories in England before it was seen in America. As an instance of the saving accomplished, it was stated that a certain article which cost 2s. 8d. to machine on an ordinary lathe is now done on a "capstan" lathe for 4d. We have no doubt that our correspondents could show a much higher ratio than 10 to 1. How about bicycle wheel hubs, for instance?

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Our London correspondent, Mr. Wm. H. Booth, has resigned his position with the Le Grand & Sutcliff Artesian Well Co., and has opened a consulting engineering office at 29 Great George street, London, where he will give attention especially to steam and hydraulic work and matters connected with artesian wells, and also will undertake to introduce American machinery and inventions in England.

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The Abuse of Formulae.

BY CHAS. L. GRIFFIN.

Current mechanical literature is teeming with formulæ which interest alike the engineer and the intelligent mechanic. Formulæ are the tools of engineering, as the lathe, planer and milling machine are the tools of construction. Like the latter, they are subject to abuse, and a further similarity exists in that skill and judgment are required for their proper use. A formula is not automatic, and its work must be calipered and gaged by sense and thought, else it will be like a micrometer in the hands of a blacksmith's helper.

Much of the text accompanying valuable formulæ in the technical press is so positive and uncompromising that considerable opportunity is offered—nay, even forced upon one—to go astray. As an example, an article is at hand on the strength of gear arms. It begins with the statement that heretofore no formula has existed which could be relied upon. It then goes on to develop a formula, and ends with a statement of infallibility that it has been used in practice, with equal facility and correctness, in designing small-lathe change gears and the gears in the heaviest rolling-mill trains! Now, however correct the formula may be, the absolute phraseology is wrong, and conveys a wrong impression. The literal interpretation of a gear-arm formula between such wide limits is not good engineering. Beyond certain limits any formula can only be used as a suggestion, and cannot be held as correct for a positive result. Yet in the example cited the formula is left with the reader, without qualification, as

of universal use in grinding out correct proportions.

It needs no strong invitation to abuse a formula. It is easier to work outside the limits than to keep inside. The latter requires thought and judgment, the former neither. Engineering would be easy indeed were it a process of mere grinding out results from a formula mill. The proper formula by no means implies a correct result. A formula is a conditional statement. Under the exact fulfillment of conditions the deduction is unquestioned. Under any other circumstances the result is valuable, but only as one to be modified more or less according to the degree of variation from the established conditions of the formula. The danger of abuse is evident. An intelligent and educated engineer has been heard to say that he checked his calculations by guesses, and stood fully as much by the latter as by the former. Of course, he was a Yankee; but even then the statement seems pretty strong. However, there is much food for reflection in it. The same engineer, given sharply defined conditions, was notably a great stickler for his calculated results and the literal acceptation of them. The inference is that his preference for guesswork was not quite as strong as he stated it, and that his success lay not only in using the right formula at the right time, but in his intelligent mechanical interpretation of it. Too often we see a man's good judgment blinded by his infallible reading of a formula. If the formula "says so" against his good judgment, it is time to hold up and study the conditions of the case, and it is not always that the formula wins success in the tussel which follows.

Capable men are heard to remark that engineering is almost entirely a matter of good judgment anyhow, and that the everlasting processions of formulæ confuse more than they assist. Admittedly, this savors of the truth but it is doubtful if these men practice quite what they preach. The principles of mechanics are most clearly stated and easiest remembered as formulæ. The results of years of experience are most available in the shape of formulated rules. Whether they are carried in the head or reduced to notebook memoranda, the engineer is continually seeking to condense his information. The formula does this. It is an epigram, containing the essence of a vast amount of study. If engineering is good judgment, it is unquestionably true that good judgment in the selection and use of formulæ constitutes the bedrock for the foundation of successful practice.

Many of our young technical graduates leave college "formula-bound." Armed with notebooks and formula cards, they strive to meet engineering problems with these weapons, dispensing with the necessity of securing a workshop standpoint wherefrom to interpret them. The result is familiar to us all. Correct and valuable formulæ seem incorrect and useless, and the shop creations in accordance with them are a failure and a menace to the advantages claimed for technical education. These young men do not know what their results mean, or their relation to manufacture. An instance is cited where a young draftsman "worked his formula" and achieved the result of a pulley 14.89 inches in diameter to mate with one 6 inches in diameter, thereby hoping to secure a speed ratio of two to one. If he had known about an allowance for slip, even though his judgment were "off," he might have been forgiven; but he didn't. Fortunately, our pride in technical education is not misplaced, for our graduates are in the main, by trained thought, fortifying themselves against such mistaken confidence in formulæ as that above.

The indicator diagram, the motor characteristic—in fact, the whole multitude of cases of graphical diagrams—are formulæ of an intensely practical sort, in which lines play the part of quantities. Nothing, perhaps, assists so largely in the study of phenomena, and in deductions therefrom, as a plotted curve. It is through the careful study of the indicator card that the steam engine has reached its present point of excellence. This might be termed a reverse method of working, for we have taken our theoretically perfect card, or formula, and constantly striven to adjust the conditions to bring its perfect fulfillment. Hence, we see that in handling a formula the engineer may treat it in two ways—he may stand by it and devote his thought to perfecting conditions, or he may accept his conditions and modify his deduction from them. A consideration of this fact in every case will prevent the abuse of valuable engineering data.

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Technical Education in India.

"A shrewd writer in the 'American Machinist' stated, in dealing with the question of the efficiency of workmen, that the secret of manufacturing supremacy lies not in cheap labor, but in cheap production. We have no lack of cheap labor in India, from the agriculturist on two annas a day, to the university-bred B.A or M.A. who works for nothing in some office and lives on the prospect of a very small wage at some indefinite future period. We have tried cheap labor on many ventures with disastrous results. The making of card fillets, in Bombay, with English machines and wire, for instance; the cheap labor damaged the machines, and the fine steel wire was ruined in the first monsoon. The tinning of sardines on the southwest coast has been a miserable failure, in spite of cheap labor, cheap fish and cheap oil. The lack of promptitude, cleanliness, and skill at the factory, resulted in goods that were unsalable.

"Whatever happens, the knowledge of the arts of labor among her working population continues to be India's greatest need, for it is industrial ignorance that stands constantly in the way of the profitable investment of capital. Switzerland contains a greater proportion of skilled artificers in her population than any other country. India is equally conspicuous for the small number of her skilled artificers, not only when compared with her total population, but even in comparison with the total of craftsmen of all sorts.

"Manual expertness is quite independent of scientific and literary training. The Sheffield cutlers and file-cutters worked just as well before they could read and write as they do now. The quality of good workmanship has not improved during the last sixty years; it is the cost of it that has been diminished by the progress of science; but European applied science rests upon a foundation of sound and good workmanship among a race of artificers whose skill is centuries old.

"There is no necessity to put the Indian artificer at once on a par, mental and physical, with the European artificer; but there is a certain amount of necessary knowledge which he lacks, and which would very considerably increase his value, both as a wage-earner and a tax-payer, and this knowledge is of precisely the same quality as that which gave the British artificer his high position as a craftsman long before the advent of Board Schools. A knowledge of hand tools and how to use them, of measurements and how to follow them correctly, and a reasonable effort to carry out instructions literally and strictly, should form the chief part of the employer's ideal.

"This is certainly a very modest demand; but it means a great deal to the employer, and it indicates how low is the standard of average competence at the present time. An artificer who knows how to use his strength to the best advantage, who keeps his tools in good order and does not spoil work, is worth in India from 50 to 100 per cent. more than his fellows in the matter of pay. Divested of the higher education, the technical school gains enormously in practical value. The teachers require less training and less pay. Any well-lighted shed will serve as a workshop, and the instruction is such as tells most quickly on a man's value in the labor market. His want of method is his chief drawback, and it is with a view to meet his most urgent needs that we advocate this method of cheap but practical instruction."—"Indian Textile Journal."

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Engineers' Needles Should Have Eyes.

Edward A. Cummings is fifty-one years old, healthy and robust, and by occupation a stationary engineer in Lyons, Wayne County. On the morning of June 7th last Mr. Cummings overslept, and upon getting up found that he had but a few minutes in which to get to work. To make matters worse, the rear collar button on his shirt was gone. He

looked around and espied a sewing needle, the eye of which he had broken off in sewing on a button a few days previous. With this eyeless needle the shirt ends were pinned together, the needle doing duty as a button. The needle staid in position all right until evening without any discomfort to Mr. Cummings.

In the evening, as he was about to go to bed, Mr. Cummings reached behind his head to remove the needle and was surprised to find that it was gone. Two days later Mr. Cummings began to feel excruciating pains in the right shoulder and down the right side. These pains were so severe that on July 15th he was obliged to quit work and consulted Dr. Myron E. Carmer, who, thinking that rheumatism was to blame, prescribed liniments and mustard plasters, both of which were used with good effects, and at the end of a week Mr. Cummings went to work again.

Then the pains began bothering him again, and seemed to keep moving down the right side, lower each day. It was with great difficulty that Mr. Cummings was able to keep his position until March 28th, when he resigned, saying that he was bothered so much by rheumatism that he must leave the place, as it was damp. On April 1st Mr. Cummings was seized with sharp pains right below the right hip, which bothered him so much that he began an investigation, which revealed a little bunch about the size of a pea. The spot was very much inflamed, and applications of liniment did not allay the pain.

At last Mr. Cummings went to Dr. M. A. Veeder's office and submitted to an examination. After examining the inflamed spot, Dr. Veeder prescribed liniment and hazarded the opinion that a carbuncle might be forming. The sick man managed to walk home and got to his room, when he was seized with more intense pain than ever before. It seemed as if his clothing was irritating something, and was driving it into his flesh. He removed his clothing from the part affected, and discovered the red spot, and in the center of it something protruding a short distance which looked black. He rubbed his hand over the spot lightly, and gave a shriek of agony. He then grabbed hold of the black object and pulled out the headless needle, which was discolored but not rusty. The next morning Mr. Cummings showed Dr. Veeder the needle, at the same time recalling the instance when he had used it to do duty in place of a button. Since removing the needle Mr. Cummings has experienced no pains.—Buffalo "Express."

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Recent Inventions in Metal-Working Machines and Tools.

Figs. 1 and 2 show plan views of two forms of draw-benches for pipe-welding, both the invention of Mr. P. Boyd, of Wheeling, W. Va.

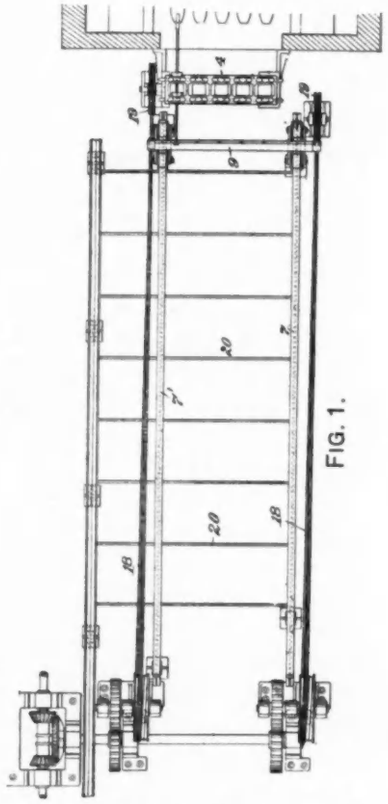
In the modification shown in Fig. 1, the crosshead 9, to which are attached the drawing tags, is driven by cables 18 from reversing gearing, the idlers 19 being placed to permit the return of the crosshead to the bell-holder.

As shown at 4, there is a series of holders for the welding bells, which latter are arranged in tandem pairs, and may be shifted so that each skelp is drawn directly from the furnace without lateral movement or interference with other skelps.

Rail 7^1 is placed higher than rail 7, so that inclined skids 20 may carry the pipe just welded beneath the same to the conveying trough at the side.

The construction shown in Fig. 2 draws by means of hydraulic or steam cylinders, and the single bell-carrying frame 4 is shifted along a rack by a pinion and handwheel 10.

The rails on which the crosshead truck moves are considerably elevated, and the



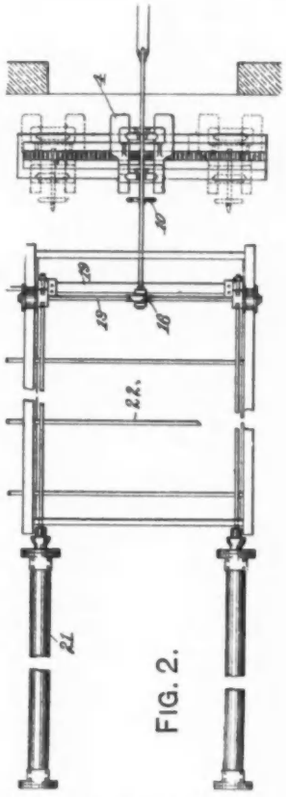
DRAW BENCH FOR PIPE WELDING.

tag holder depends from a pulley 16, and passes behind the bar 19, some distance below the axis 13 of the truck wheels. The skids 22 are inclined as in the construction above described.

Fig. 3 shows in side elevation a punch and shear mounted on the same frame, and both driven from the same steam cylinder; the levers *D* and *G* of the punch and shear being attached on opposite sides of the piston rod.

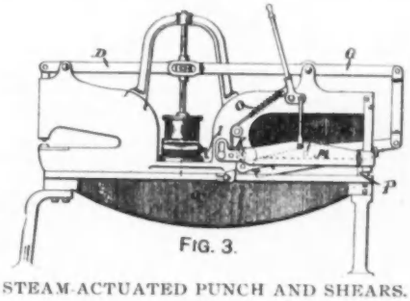
I is the controlling valve; *K* a stud and roller placed just above the rounded heel of the shear, and serving to carry a portion of the strain of the shear pivot. At *L* are holes for placing this stud for use with different forms of shears.

The hold-down bar *M* receives the link



ANOTHER STYLE OF DRAW BENCH.

of the hand lever in front of the center, and the spring *O* acts to positively lift the heel of this bar when the lever is raised. *Q* is a squaring gage, and *P* a throated



STEAM-ACTUATED PUNCH AND SHEARS.

strengthening block set at right angles to the throat of the shear.

The machine is designed and patented by Mr. C. A. Bertsch, of Cambridge City, Ind.

▲ ▲ ▲

D. L. Ballard, who for twenty years has been connected with the Hendey Machine Co., and represented them at Chicago, has recently engaged with Hill, Clarke & Co., of Boston.

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A decimal point is often of considerable importance. The specific gravity of cork is .24, while that of platinum is only 22.

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▲ ▲ ▲

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We invite correspondence on subjects pertaining to machinery.
Name and address must always be given, though not necessarily published.
Communications for or relating to the reading columns should be addressed to the Editor. All business communications should be addressed to the Company.
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A Phase of the Wage Question.

A rather curious phase of the wage question came up the other day when a manufacturer of a device used by machinists complained to us that he could not get ordinary salesmen to introduce it successfully, because such men could not go into a machine shop and demonstrate its working qualities. Machinists were required for this, but there was always trouble with the machinists who tried it.

By a little questioning we found that the trouble complained of came from the fact that a machinist who might have been making, say, $2.50 or $3 per day in the shop, and was at first perfectly satisfied to go upon the road for about the same wages, above his traveling expenses, would always demand much more than this as soon as he had become fairly broken in as a salesman.

Our manufacturer thought this was entirely unreasonable, and that machinists were a very perverse tribe, which was the same thing as thinking that a machinist possessing, besides his skill and experience as a mechanic, the address and general ability necessary to make a good salesman, ought to be perfectly content to work as a salesman for much less than salesman's wages.

It seemed to us that it was the manufacturer who, in this case, was unreasonable, instead of his machinist-salesman, and that nothing else could be expected of a man possessing the qualifications demanded but that he would endeavor to get for himself the ruling rate of compensation for the kind of service rendered. A man who would not do this is evidently not born to be a successful salesman, and if anyone can point out to us why a good salesman—one who would ordinarily command a salary of $2,500 or $3,000 a year and expenses—should work for a third of this amount simply because he had formerly been a machinist, we should be interested in the demonstration.

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The "Indiana."

The Navy Department has received the report of the final or efficiency trial of the battleship "Indiana." Her hull, engines, machinery and fittings were pronounced satisfactory. The trial took place on the voyage between Port Royal, S. C., and Norfolk, Va., which run the "Indiana" made in forty hours. Under natural draft and with only four boilers in use, she maintained an average speed of 13½ knots. The horse-power developed was nearly 5,000. The percentage of the contract price retained to insure any changes or repairs for which the contractors might be liable, will now be paid to the Messrs. Cramp.

By the way, we have heard that the "Indiana" carries some heavy guns, that she was, in fact, built for carrying them; how can a trial of her be complete and satisfactory without firing a gun with a full charge? Would any one dare to make the trial?

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Captain John W. Collins.

We take great pleasure in the announcement that the salary of the Engineer-in-Chief of the United States Revenue Cutter Service has been advanced by the action of Congress. Mr. John W. Collins, whose salary was $1,800 per year, is now to have the rank and pay of a Captain in the service, the pay being $2,500.

Captain Collins has been in the service of the Government for thirty-two years, two of which he served as a Third Assistant Engineer in the Navy during the War. He has served in every grade of the Revenue Cutter Service, and is thoroughly familiar with all of the requirements of the engineering branch of the service. At various times he has been selected to fill positions of honor and trust. He has been Chairman of the American Institute Committee on Steam Machinery, New York City; was a member of the Advisory Council of the Engineering Congress at the World's Columbian Exposition, and Secretary Windom appointed him as Consulting Engineer to the International Marine Conference, and charged him with the revision of the steamboat inspection laws.

Keeley seems to be rather more than usually active of late, and some meetings have been held in Philadelphia at which different deluded individuals endeavored to explain to each other just why the motor ought not to be expected to "mote" for some time yet.

One man thought the company should go ahead and secure patents, whereupon another member of the company, evidently better acquainted with the peculiar difficulties of the case, said it "would be months before it would be possible to understand the system well enough to draw up specifications which would be accepted in the Patent Office."

Some ignorant persons may scoff at this; but anyone who has ever tried to understand any single sentence of Keeley's discourses, ostensibly intended for the enlightenment of the public, will have no difficulty in believing the statement, and will, in fact, be disposed to believe that the Patent Office men will never be able to understand it at all, no matter how many months may be previously devoted to preparatory study designed to make it easy for them.

A much greater and more incomprehensible mystery than Keeley's motor, however, is Keeley himself and the mysterious influence he seems able to exert over the minds of people who in all other respects seem sane.

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Death of Thomas H. Watson.

Thomas H. Watson, of the Hydraulic Machinery Works of Watson & Stillman, of New York City, died on April 6th.

Mr. Watson's life was peculiarly uneventful, and has seldom been paralleled in this country. He was born in England in 1836, and was brought to New York by his parents when two years old. He attended the public schools of the city, and then became an apprentice in an East Side machine shop. He was foreman for Dudgeon & Lyon when still very young, and became superintendent about 1860. In 1876 the firm of E. Lyon & Co. was formed, the partners being E. Lyon, Mr. Watson and Francis H. Stillman. On the death of Mr. Lyon in 1883, the firm became Watson & Stillman. Mr. Watson's whole industrial and business life was thus a continuation of his original business connection, and the principal line of manufacture, that of hydraulic machinery, continued the same throughout. Mr. Watson's health had not been good for the last three or four years, although he was at the works daily until within a couple of weeks of his death.

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Charles Franklin Frye, foreman of the machine shop of the Pennsylvania road at Crestline, O., died March 4th, at the age of 34 years. Mr. Frye was an able man, and was highly respected by all who knew him.

Questions and Answers.

Name and address of writer must accompany every question. Questions must pertain to our specialties and be of general interest. We cannot undertake to answer questions by mail.

(87) J. H. S., Newport News, Va., asks: 1. For an easy and correct method of ascertaining the circumference of an ellipse from its diameters. 2. For a similar method of finding the diameters when its area and the ratio of its diameters are known. 3. For a similar method of finding its diameters when its circumference and the ratio of its diameters are known. A.—1 and 3. There are no simple accurate formulas known for these purposes. 2. If D and d are the diameters, the area is expressed by the formula $D \times d \times .7854$. If $D = rd$ this becomes: area $= rd^2 \times .7854$, and by transposition,

$$d = \sqrt{\frac{\text{area}}{r \times .7854}}$$

(88) J. Y. J., Richmond, Va., writes: I would like to know the dimensions for a Bessemer steel screw, screwed into cast iron that will bear a weight of 28,000 pounds, allowing a factor of safety of 2. A.—The elastic strength of Bessemer steel may be taken at 40,000 pounds per square inch. We want to sustain $28{,}000 \times 2 = 56{,}000$ pounds, and the sectional area of the screw at the bottom of the thread should therefore be, 40,000 : 56,000 : : 1 : 1.4 square inch. Referring to the table of United States standard screw threads, we find the area of 1.515 for a screw 1⅝-inch external diameter (5½ threads to the inch), and this size it would be proper to use under the conditions given. The factor of safety is quite low for any purpose, and we would prefer a 2-inch screw, 4½ threads to the inch. The safety factor would then be above 3.

(89) P. W. C., Columbus, Kan., asks: In calculating the magnetizing force of a magnet coil, does the E. M. F. cut any figure in the case? Suppose that in two different cases the current in amperes and the number of turns are the same, but in one case the E. M. F. is 55 volts, while in the other case the E. M. F. is 110 volts, will there be any difference in the strength of the fields? A.—The strength of the field magnets depends upon the ampere turns. The voltage has nothing to do with it, except that it determines the number of amperes. Should the voltage of a given magnet coil be doubled, the amperes would be doubled. With two magnets having the same number of turns, but one of double the resistance of the other, the larger resistance having double the voltage behind it, the amperes and the magneto-motive force would be the same in both cases. We assume that our correspondent understands the influence of the size and material of the core on the actual strength of the magnet.

(90) N. K. W., New Bedford, Mass., asks: 1. Is a fuse on a lamp circuit for the protection of the lamps or the wire? 2. Name a good book giving information on testing dynamos for faults. 3. Can a good knowledge of steam engineering be obtained from a correspondence school? 4. When two or more dynamos are run together, why must the voltage of the machines be equal without regard to the current of each? A.—1. The lamps. 2. We think Prof. Crocker's book on the care and running of dynamos will meet your wants as well as any. 3. We have great confidence in the International Correspondence School, of Scranton, Pa., and have no doubt you would be more than satisfied with its course of instruction. 4. If dynamos are connected in multiple the voltage must be equal, or otherwise the stronger would prevail over the weaker and force the current through it backwards. If they are connected in series this no longer holds, as the voltages of the two machines are added together and the current through each is the same, as they form part of the same circuit.

(91) L. M. I. asks: What would be the horse-power of a compound engine 12 inches and 22 inches by 42-inch stroke, at 120 revolutions per minute; boiler pressure 120 pounds, receiver pressure 10 pounds, vacuum 26 inches; no indicator diagrams being accessible? Would you add the equivalent of the vacuum, 13 pounds, to the receiver pressure and take the mean effective of 23 pounds (or 20 pounds, allowing for loss, etc.), or would you add 10 pounds to the boiler pressure and take the mean effective of 130 pounds? A.—The question does not state whether the boiler pressure as given is gage or absolute; we will assume it to be the gage pressure. For the first cylinder we would find the absolute mean effective pressure for the given cut-off, and deduct the atmospheric pressure and the receiver pressure with, say, 2 pounds additional: $78.57 - (15 + 10 + 2) = 51.5$. The computed horse-power of the first cylinder then would be: $12^2 \times .7854 \times 51.5 \times 7 \times 120 \div 33{,}000 = 148$ H. P. For the second cylinder the absolute mean effective would be 14.55 pounds, and from this we would deduct, say, 4 pounds. The horse-power of this cylinder would then be: $22^2 \times .7854 \times 10.5 \times 7 \times 120 \div 33{,}000 = 101$ H. P. We do not know whether the data given us are from an engine in actual operation or not. It would seem that the receiver pressure and the proportional horse-power of the second cylinder should be higher than here given.

(92) R. T. T., Torrington, Conn., writes: Please give a rule for selecting gears to cut threads on lathes, for both single and compound gearing. A.—If the lathe is simple-geared, and the stud runs at the same speed as the spindle, then select some gear for the screw, and multiply its number of teeth by the number of threads per inch in the lead screw, and divide this result by the number of threads per inch which you wish to cut. This will give you the number of teeth in the gear for the stud. If this result is a fractional number, or a number which is not among the gears which you possess, then try some other gear for the screw. But if you prefer to select the gear for the stud first, then multiply its number of teeth by the number of threads per inch which you wish to cut, and divide by the number of threads per inch on the lead screw. This will give you the number of teeth for the gear on the screw. If the lathe is compound, select at random all the driving gears, multiply the numbers of their teeth together, and this product by the number of threads you wish to cut. Then select at random all the driven gears except one, multiply the numbers of their teeth together, and this product by the number of threads per inch in the lead screw. Now divide the first result by the second, and you will have the number of teeth in the remaining driven gear. But if you prefer, you can select at random all the driven gears. Multiply the numbers of their teeth together, and this product by the number of threads per inch in the lead screw. Then select at random all the driving gears except one. Multiply the numbers of their teeth together, and this result by the number of threads per inch of the screw you wish to cut. Divide the first result by the last, and you will have the number of teeth in the remaining driver. When the gears on the compounding stud are fast together, and cannot be changed, then the driven one has usually twice as many teeth as the other, or driver; in which case you can, in the calculations, consider the lead screw to have twice as many threads per inch as it actually has, and then ignore the compounding entirely. Some lathes are so constructed that the stud on which the first driver is placed revolves only half as fast as the spindle. You can ignore this in the calculations by doubling the number of threads of the lead screw. If both the last conditions are present, you can ignore them in the calculations by multiplying the number of threads per inch in the lead screw by four. If the thread to be cut is a fractional one, or if the pitch of the lead screw is fractional, or if both are fractional, then reduce the fractions to a common denominator, and use the numerators of these fractions as if they equaled the pitch of the screw to be cut, and of the lead screw, respectively. Then use that part of the rule given above which applies to the lathe in question. For instance, suppose it is desired to cut a thread of $\frac{25}{32}$-inch pitch, and the lead screw has 4 threads per inch. Then the pitch of the lead screw will be ¼ inch, which is equal to $\frac{8}{32}$ inch. We now have two fractions, $\frac{25}{32}$ and $\frac{8}{32}$, and the two screws will be in the ratio of 25 to 8, and the gears can be figured by the above rule, assuming the number of threads to be cut to be 8 per inch, and those on the lead screw to be 25 per inch. But this latter number may be further modified by conditions named above, such as a reduced speed of the stud, or fixed compound gears. In the instance given, if the lead screw had been 2½ threads per inch, then its pitch being $\frac{4}{10}$ inch, we have the fractions $\frac{4}{10}$ and $\frac{25}{32}$, which, reduced to a common denominator, are $\frac{64}{160}$ and $\frac{125}{160}$, and the gears will be the same as if the lead screw had 125 threads per inch, and the screw to be cut 64 threads per inch.

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Business Specials.

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Adding Machine. Grant: see page 25.

Forming Lathes, Mer. Mach. Tool Co., Meriden, C.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Honest Mach. Oils. F. S. Pease Oil Co., Buffalo, N. Y.

Engine Castings ⅛ to 2 H. P. Finished boilers and engines. Grant Sipp, Paterson, N. J.

Bevel and miter gears cut with perfect planed teeth. Boston Gear Works, Boston, Mass.

Aluminum and Brass Castings, Machinery, Name Plates. Twining Campbell, Paterson, N. J.

Marine Iron Works, Chicago, builders of steam yachts and marine machinery; catalogs free.

Best Presses and Dies for all sheet metal work. Ferracute Machine Company, Bridgeton, N. J.

Just Issued—Catalog 8. No. Mailed free. Clayton Air Compressor Works, 28 Cortlandt st., New York.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N. Y.

Key Seaters for any length of hub or width of keyway. New, handy machines. Mitts & Merrill, 913 Tilden street, Saginaw, Mich.

Duplex and special gear cutters, counterbores, cutter and surface grinders, vertical millers, hand punches and shears. R. M. Clough, Tolland, Conn.

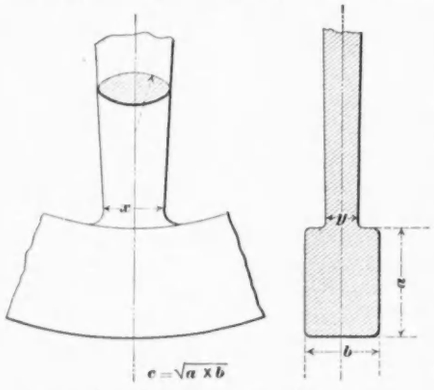
Patent Soliciting of High Class.—D. Walter Brown, Counsel in Patent Cases, 111 Broadway, New York. Send for "Brief History of Patent Legislation."

Arms of Whole Pulleys and Fly-Wheels.

BY F. A. HALSEY.

Formulas for pulleys and fly-wheels, based on the working forces and the strength of the materials used, have been published in profusion. So far as these relate to segmental or built-up wheels, in which the shrinkage strains are eliminated, they are entirely legitimate; but they have no proper application to pulleys and fly-wheels cast in one piece. In such wheels the shrinkage strains are liable to be far in excess of those due to the working load, and adequate provision for the former will include all necessary provision for the latter. Very few have ever seen whole pulleys or fly-wheels fail from the strains due to the load, but those which pull apart in the foundry are common enough.

It is undoubtedly true that the safest guide in this class of work is an eye which has been educated in the school of experience, and a pulley or fly-wheel which satisfies such an eye may be set down at once as a safe one. The eye as a guide can only be applied, however, to pulleys which have been made and can be seen in the iron. At the point where a guide is needed most, namely, at the drawing-board, the eye fails entirely. In the iron



Arms of Pulleys and Fly Wheels.
American Machinist

the eye takes in the parts of the pulleys as volumes or masses, while in the drawing the linear dimensions only appear. Volumes vary as the cube of their dimensions; whence it follows that parts which from their drawings seem well-proportioned, look very differently when seen in the iron. This applies to all drawings, and is the main reason for the difficulty of judging from a drawing how a given part or machine will look when done. If the drawing is to a scale instead of being full size, the difficulty is, of course, greatly increased.

In point of fact, there are few details of machine work of which the drawings are more deceptive in this respect than pulleys and fly-wheels. As a rule, the arms look heavier in the drawing than in the iron; and I have seen those which in the drawing seemed to have excessively heavy arms, turn out, when made, to be of the spider-web variety.

Since, then, the eye is an unsafe guide at the point where such a guide is needed most, the need of a formula of some sort is felt. If such a formula is based on and represents successful experience, it will furnish an excellent and sure guide within the range of its proper application, and pulleys made from such a formula can be depended on to satisfy the eye when done. Many years ago "Chordal" published in these columns a set of such formulas for light-rim belt pulleys, in which the width and thickness of the arms were made to depend upon the diameter only. The writer has had occasion to design quite a range of sizes of heavy-rim fly-wheels cast in one piece, and after comparing the resulting wheels—some of which were satisfactory, while others were not—has deduced a formula which represents the best wheels of the lot. This formula is based on "Chordal's" with a larger constant and with an addition to provide for the influence of the metal in the rim, as it is obvious that in two wheels of the same diameter, but with different weights of rim, the metal in the arms should not be the same, but should vary with the rims. The dimensions of the rim section cannot be used directly, owing to the varying proportions of the rim. Thus, in the figure, the dimension of the rim in a radial direction is greater than that in the axial direction. Some other designer's fancy might, however, lead to the reverse arrangement, while a third might make the section a square. If these three forms of section have the same area, they should have the same influence toward determining the dimensions of the arm, although no single dimension is common to any two of them. To meet this condition, sections of whatever shape, but of the same area, must be considered as equivalents, and this is carried out in the formula by making the factor for the rim section the side of a square, equivalent in area to the actual section, whatever its shape may be.

Referring to the illustration for the notation, the formula for heavy-rim fly-wheels is as follows:

$$x = 7/8'' + .04\,d + .153\,c.$$

Taper of arms each side the center line, ¼ inch to ⅜ inch per foot in side view, and ⅛ inch to 3-16 inch per foot in edge view, depending on size of hub.

For belt pulleys, the factor giving the influence of the rim is neglected, and by omitting the last term we have for a double belt pulley,

$$x = 7/8'' + .04\,d,$$

which, by subtracting ½ from ⅞, becomes, substantially, "Chordal's" original formula for single belt pulleys, namely,

$$x = 3/8'' + .04\,d.$$

In all cases, $y = \frac{1}{2}x$. My own taste in the matter of proportions of the rim section is to make $b = \frac{2}{3}a$.

The above formula for heavy-rim wheels has been applied to wheels from 33 inches to 8 feet diameter, with very satisfactory results. How much beyond this range it is applicable cannot be said without experience; but should a wheel be wanted in one piece of that size, I should not hesitate to apply it up to 12 feet diameter.

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St. Louis Meeting of the American Society of Mechanical Engineers.

The official programme of the meeting of the A. S. M. E. has been issued, and shows that the order of proceedings will be about as usual. The list of papers to be read is as follows:

Keep, Wm. J.—Strength of Cast Iron.

Kent, Wm.—The Efficiency of a Steam Boiler. What Is It?

Eldridge, A. H.—Tests of a Four Cylinder Triple Expansion Engine and Boiler.

Hale, R. S.—Determining Moisture in Coal.

Kettell, Chas. W.—A Study of the Proper Method of Determining the Strength of Pump Cylinders.

Goss, W. F. M.—The Effect upon Diagrams of Long Pipe Connections for Steam Engine Indicators.

Carpenter, R. C.—A New Form of Steam Calorimeter.

Hoffman, J. D.—A Hydraulic Dynamometer.

Henderson, Geo. R.—Spring Tables.

Whitham, Jay M.—Effect of Retarders in Fire Tubes of Steam Boilers.

Whitham, Jay M.—Experiments with Mechanical Stokers.

Thurston, R. H.—Superheated Steam.

(Concluded on page 445)

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Help Wanted.

Situation and Help Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. The Cash and Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

TO SUBSCRIBERS

whose names appear on our subscription list, this paper will give two free insertions under this heading to those in want of positions. The advertisement to occupy a space of not more than five lines. Additional space or insertions must be paid for in advance at regular rates.

Situation wanted by first-class pattern maker. Address, Lab., AMERICAN MACHINIST.

Mechanical draftsman and first-class tracer is open for engagement. Address G. L., AM. MACH.

Contractors and mfrs wanting a live agent in W. Mich., add. V. Sebring Hillyer, Grand Rapids, Mich.

Mechanical draftsman wants position; first-class man; experienced in hoisting engines, tools and mill work. BOX 98, AMERICAN MACHINIST.

Wanted.—An experienced pattern maker to take charge of pattern shop in architectural iron works. Address James McKinney & Son, Albany, N. Y.

Pattern maker desires pos. as foreman in a mfg. company. Exp. in pump and engine wks and gen'l mach. pat'ns. Sober & energetic. Box 94, AM. MACH.

Exp. brass f'ndry f'man would like to correspond with parties requiring the services of a competent man. Add., Up-to-Date, care AMER. MACHINIST.

Wanted—To sell and a position to superintend the manufacture of same, A No. 1 gasoline engine, from 1 to 20 horse power. E. S. C., AM. MACHINIST.

Wanted—Situation by an A-1 machinist in flour mill or machine shop. Corrugating and grinding rolls a specialty; also handy at the forge. Box 87, AMERICAN MACHINIST.

Assistant foreman wanted in a Corliss eng. shop near New York; one well up on tool work. Address, giving age, experience and references, Foreman, Box 96, AMERICAN MACHINIST.

Wanted—Sit. as foreman, assist. foreman or job hand, by man with thorough knowledge of mach. business. Will take job as ordinary machinist at ordinary pay. J., AMERICAN MACHINIST.

Wanted—Experienced mech. draftsmen, North and West, having evenings free. State where regularly employed. Edwin Guthrie, Patent Attorney, Corcoran Building, Washington, D. C.

Wanted—Position as foreman by young man, 31 yrs. old. Experienced in special and automatic machinery and general machine work; fair draftsman and designer. H. O., AMERICAN MACHINIST.

Wanted—Thor'ly prac. mech'l dftsman, must be exp. mach. designer; only those capable of being engaged on probation need apply; state refs. and sal. expected: position in Phila. Box 97, AM. MACH.

Wanted—Situation as supt. or foreman. Designer of special tools and fixtures for brass and iron. Knowledge of patterns and core work, also management of shop and men; good ref. Box 91, AM. MACH.

Mechanical engin'r, technical graduate, open for engagement; 3 yrs.' exp. in erection of large manf. plant; engine and general machine designer; also in managing men. Box 95, AMERICAN MACHINIST.

Mechanics and Engineers out of a job can make good wages selling "No-Scale" Boiler Compound. Guaranteed to remove and prevent lime scales in boilers. Liberal commissions. Exclusive territory. Address The No-Scale Co., Indianapolis, Ind.

Do you need a supt or M. E? Advertiser has a thorough tech. education and 15 yrs practical exp. on general machine work, machine tools and automatic labor-saving machinery. Open to engagements after March. Add., Box 86, AM. MACHINIST.

Wanted—Skilled mech'c to take charge of special line of machines. Must be modern in shop practice, able to make pencil drawings, willing to work at tools or bench when necessary. Work to improve design, lessen costs, supt. const'n; permanent; sat. salary to capable worker. Box 85, AM. MACH.

Draftsman Wanted—Comp't man, familiar with mach. design'g and construct'n of jigs and tools can secure permanent sit, if satisfact'y; one who has had some experience in shop practice and is well versed in strictly modern methods, preferred. Address, stating age, experience, salary expected, etc., Competent, care AMERICAN MACHINIST.

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Miscellaneous Wants.

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S.M.York, Clev'd, O.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

Best and cheapest Bolt Header, made by C. H. Baush & Sons, Holyoke, Mass.

For Sale—A first-class key-seater, new. Address Mitts & Merrill, 913 Tilden st., Saginaw, Mich.

Light and fine mach'y to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Boye, Cincinnati, O.

Wanted.—Complete drftng room equip't. 2d h'd preferred. Rushmore Dynamo Works, Jersey City.

For Sale—Two Warner & Swasey speed lathes, in first-class condition. Penberthy Injector Co., Detroit, Mich.

For Sale, Cheap—Patterns, drawings, wood cuts, electros and negatives for 16 and 20 inch Pillar shaper, and 20 inch traveling head shaper; design up to date, and many machines already in use; reputation already established. Reason for selling, pressure of other work. Address Box 93, AMERICAN MACHINIST.

VALUABLE BOOKS

For MACHINISTS, ENGINEERS, ELECTRICIANS, Etc.

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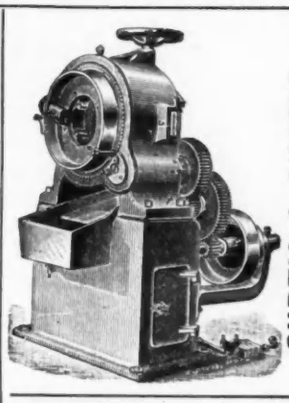

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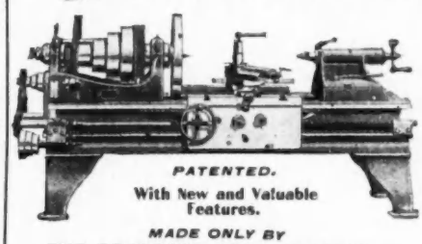

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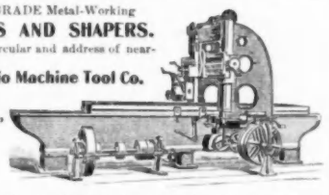

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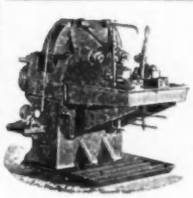

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(*Continued from page 444.*)

Bryan, Wm. H.—Western River Steamers.

Alberger, L. R.—A Self-Cooling Condenser.

Porter, H. F. J.—Hollow Steel Forgings.

Hutton, F. R.—A Classification and Catalogue System for an Engineering Library.

Murray, Thos. E.—A Steel Plate Flywheel.

The sessions will be held in the Grand Parlor of the Southern Hotel, and there will be a reception at the same place Thursday evening, the 21st. The meeting will extend from the 19th of May to the 22d.

▲ ▲ ▲

Commercial Review.

NEW YORK, SATURDAY EVENING, APRIL 18th.

Machinists' Supplies.

To look for a broadening of the market with the advancing season, is natural even if not for all classes of goods, logical. Up to this writing, however, results as reflected in the trade done by sellers in this city have been highly disappointing. So far has the season now progressed that it seems unwise to center our expectations upon any radical change in the character of business before the dull period of midsummer, which being followed by the excitement of election time, may defer improvement until that momentous event is past. Still the supply market will follow its own course and that of other lines of trade, irrespective of predictions, and if conditions are only favorable it may take a new lease of life at any time.

Though there is a brighter side to the situation, as shown by some of the letters from out-of-town manufacturers, quoted later in this article, by far the greater number of the many sellers with whom we have talked personally testify to the quietness of the market. There are, as usual, all shades of experience, some people reporting an increase of trade this month, others a decrease. Some had a more active business early in the year than at present and now look back upon that time as a mild sort of Golden Age. On the average, things appear, since our last monthly report, not to have moved far from statu quo.

Many individual lines might be made the subject of special investigation. Of several concerns handling chucks, for instance, some talk not over enthusiastically; one which sells chucks incidentally with a line of machine tools is inclined to think they are in fairly good selling; another reports, for these in connection with twist drills and reamers, for the New York office, less business than during the early part of the winter, though possibly more than a year ago. The main factory of the latter company is quite busy, however, but largely from custom of a

special nature, bicycle manufacturers being an important factor.

Power transmitting machinery seems to be about as hitherto. One company is doing a somewhat increased volume of business of a small nature, such as that for repair work, inquirers representing new enterprises being shy about placing orders.

Wrought iron pipe and fittings are extremely quiet. The prices are nominally about the same as for some time past, but jobbers are cutting manufacturers' rates.

Leather belting also is in dull selling. Prices may in some cases be lower on common grades or odd lots, but for the higher ones at least, it is not admitted that there has been any general cheapening since our last report.

The following are reports received from some New England manufacturers of chucks and of thread cutting tools.

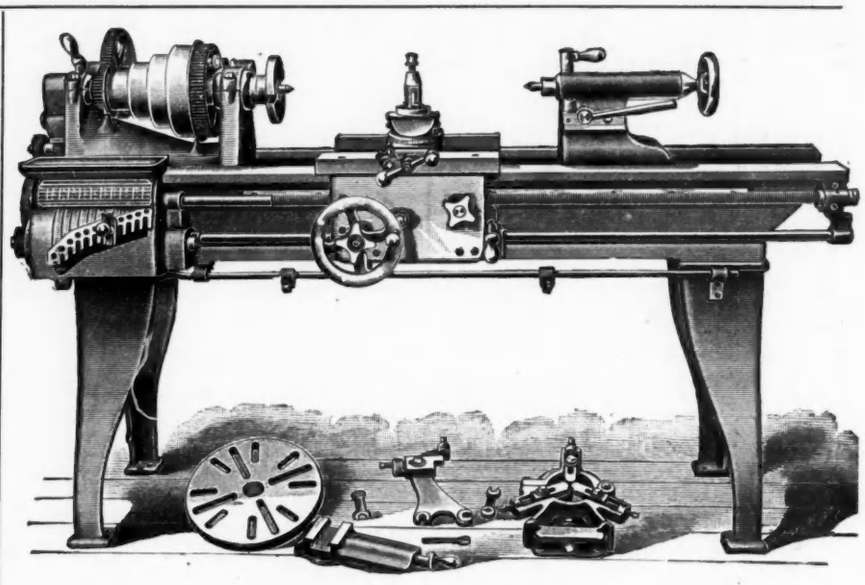
The Hoggson & Pettis Mfg. Co., New Haven, Conn., write: "Our chuck department has been unusually busy this season, and the output of the first three months this year equals the first six months of last year. We refer wholly to our home trade. While our other departments are not as busy as we would wish, we are encouraged by our chuck trade to anticipate an improved business from now on."

Another New England company manufacturing chucks say: "Our business was fairly good during the month of March, though not equal to that of '93, but better than in '94 and '95. April has opened very quiet and we can hardly decide what the result is to be for this month. From our information and experience we look upon business as being unsettled and the prospects seem uncertain as to the future. At the same time we have hopes of a better business the coming season."

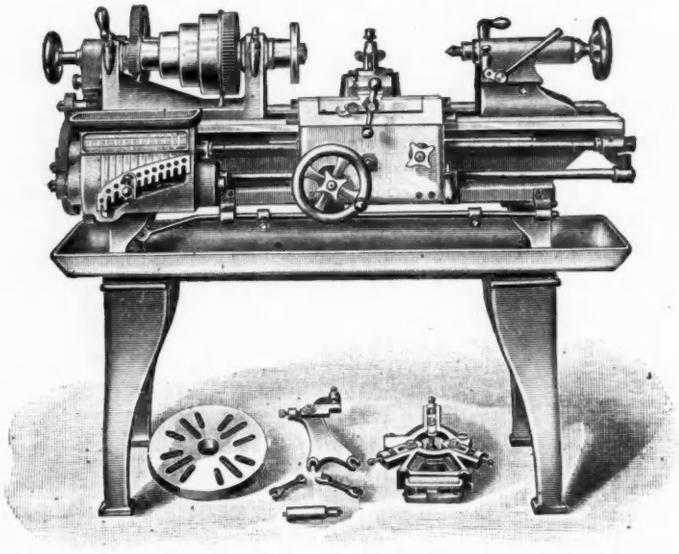
A concern manufacturing reamers, taps, dies, etc., reports that trade is keeping along much as usual and about the same as last year.

Wells Bros. & Co., Greenfield, Mass., say that screw plates are a "line of goods which is enjoying a very much improved condition over the business of a year ago. Since January 1, 1896, we have not seen the time that we were anywhere near up with our orders. Prices are firm, there having been no change during the last twelve months. We have increased our help 25 per cent., have had increased sales every month over a year ago. We are led to think that it is owing to the increase in the manufacture of bicycles, which indirectly affects our trade." A good many other people, by the way, are led to think the same thing, and without the activity in bicycle manufacture it seems as though the "American Machinist's" commercial column would have had, in the past, to be conspicuous for blank paper.

A side light upon the demand for textile machinery is cast by the results of an



14-in. x 6 ft. Hendey-Norton Lathe, and 12-in. x 4 ft. Hendey-Norton Lathe. These are modern, high-grade, practical tools, and are specially adapted for tool-room work. They have the Norton Attachment for screw cutting, giving 36 different threads and 36 different feeds with only two changes of gear, and movement of lever in gear box from one notch to the other. Note the automatic stop under apron. It will automatically stop carriage at any desired point in either direction. Invaluable for internal or duplicate work.



The 12-in. Lathe is fitted with drawing-in sleeve and American Watch Tool Co.'s Standard Chuck, used in making small taps, reamers, etc. Work finished first and cut from bar afterward. No centering required. See carriage reverse lever by right-hand side of apron; no reaching for countershaft shipper required.

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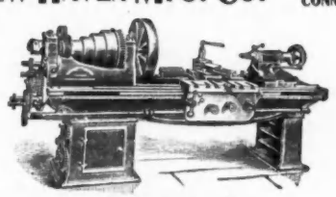
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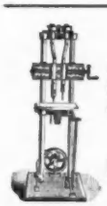
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investigation made by the "Textile Manufacturing Journal," which obtained reports from 432 mills, 256 of them being cotton mills. It was learned that the number of persons employed by them all was but 49,000 as compared with 71,599 in 1892, a decrease of about 22,600. Ninety-six of the mills were closed entirely. There are said to be thousands of textile mills in the United States, and it is not likely that those not heard from are in better shape than those that were.

Bradstreet's weekly summary of business conditions says that on the whole, trade this week presents a distinct gain; that "there is a better demand for cotton machinery to go South, Eastern cotton dyers are busier, and there is a demand for hardware, machinery and locomotives."

Iron and Other Metals.

With pig iron, it is much the same as it has been. Compared with a few weeks since, there is said to be a lull in Southern irons, and there is perhaps a better tone in some branches of the iron and steel market. Furnaces of the Pittsburgh region are piling their pig rather than sell it at the present rates, as compared with the prices of ore and coke, but it seems as though the stocks of Eastern furnaces were not thus being accumulated.

Moderate trading has characterized the metals, though tin has been fairly active in London, and copper has sold somewhat better in this market than last week.

Quotations.

NEW YORK, Monday, April 20th.

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Machinery Steel—From store, about 1.75. Special brands upward.

Cold Rolled Steel Shafting—Base size in carloads, about 2½c.; 2¾c. for smaller quantities from store.

Copper—Carload lots, Lake Superior ingot, 10⅞c.; electrolytic, 10⅝ @ ¾c.; casting copper, 10¼ @ 10⅜c.

Pig Tin—For 5 and 10-ton lots, about 13.40 @ 13.50c., f. o. b.

Pig Lead—In carloads, 3 02½ @ 3.05c., f. o. b.

Spelter—In carload lots, New York delivery, 4.07½ @ 4.12½c., for ordinary brands.

Antimony—For wholesale lots: Cookson's, 7¾c.; Hallett's, 6¾c.; Japanese, 6¾c.

Lard Oil—Prime city, 50 @ 51c., in carload lots.

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Manufactures.

Lawrence B. McCabe, Baltimore, Md., will erect water works at Govanstown, Md. An electric plant may also be installed.

A plant will be established in Parkersburg, W. Va., to manufacture oil well finishing tools. John Carothers, of Bradford, Pa., may be addressed.

A charter has been obtained for an electric light plant and waterworks for Brooklyn, Md. The water supply will be obtained from artesian wells John H. Gees is interested.

At North Chelmsford, Mass., Geo. More & Son are about to erect an addition to their woolen mill. In a short time they will also make some additions to the steam plant.

Wells Bros. & Co., manufacturers of tools and machinery, Greenfield, Mass., are contemplating building a new shop, the plans being now ready. This addition will be 80 x 100 feet.

The Wilson-Wheeler Co. have leased and acquired the business of the Windsor Machine Co., at Windsor, Vt., and will continue to manufacture screw machines and other machine tools.

The Ashcroft Mfg. Co., 111 Liberty Street, this city, have purchased from Jarvis B. Edson the business, and will hereafter be the sole manufacturers of the Edson Recording and Alarm Gage.

The Consolidated Steel and Wire Co., Braddock, Pa., is erecting a large addition to its works for the manufacture of wire nails. Twelve new machines will be installed, giving work to sixty additional men.

Willis F. McCook, of Pittsburgh, has purchased the plant of the Columbia Iron and Steel Co., at Uniontown, Pa. It is intended to remodel the mill, and it is expected that the company will be making billets about July 1st.

The Armitage-Hershell Co., of Tonawanda, N. Y., manufacturers of steam engines, boilers and merry-go-rounds, have just completed their main building, which was entirely destroyed by fire three months ago. They will resume work as soon as the necessary machinery can be set up.

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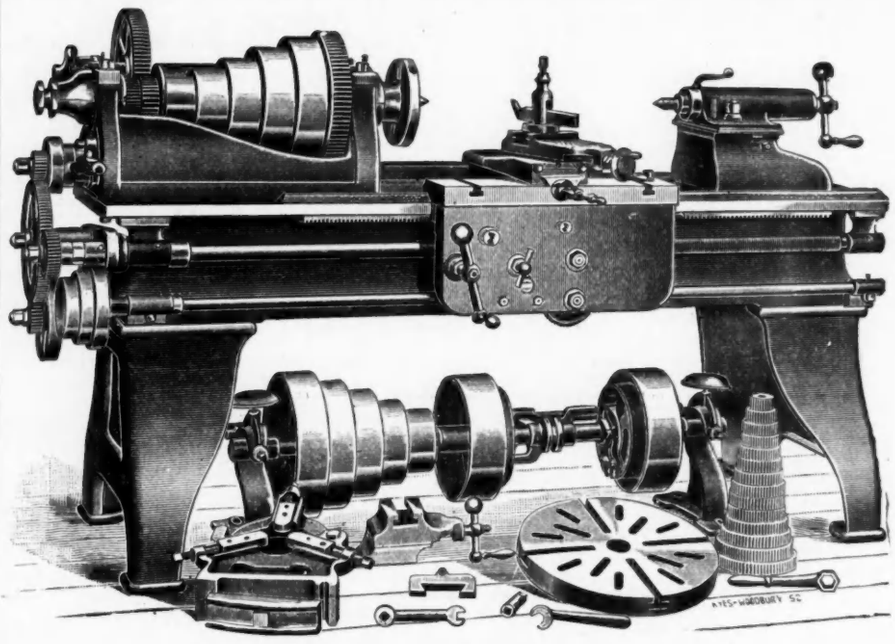

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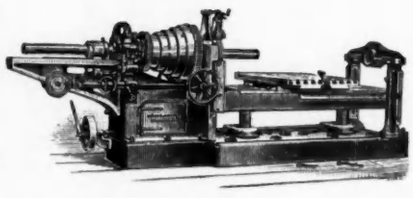

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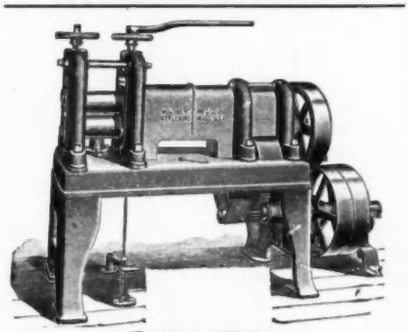

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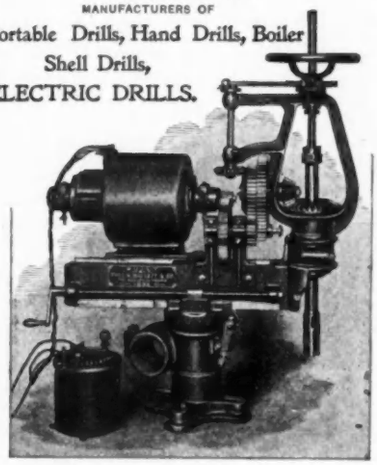

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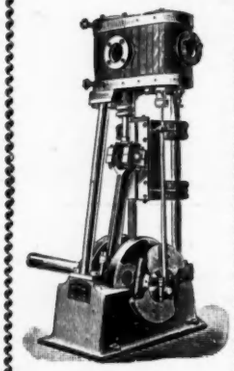

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Gould & Eberhardt, Newark, N. J.
Grant, Geo. B., Lexington, Mass.
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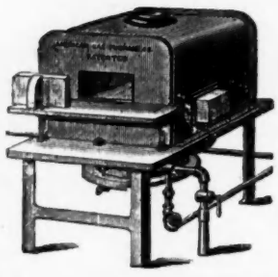
McCabe, J. J., New York.
Norton Emery Wheel Co., Worcester, Mass.
Place Machine Co., George, New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Strelinger & Co., Chas. A., Detroit, Mich.

Grinding Machine, Cock.
Foote, Barker & Co., Cleveland, O.

Continued on page 31.



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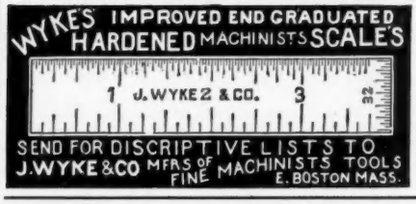
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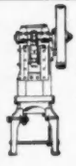

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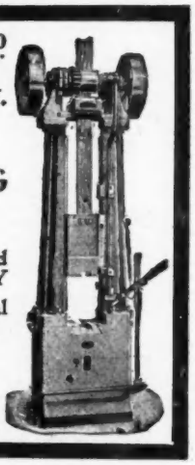

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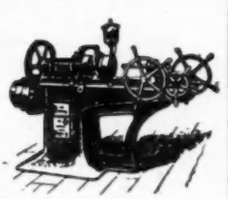

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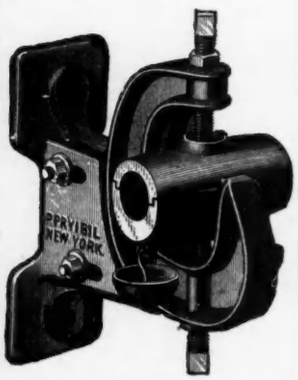

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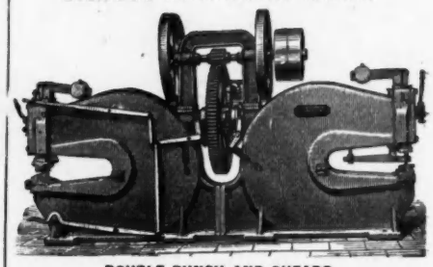

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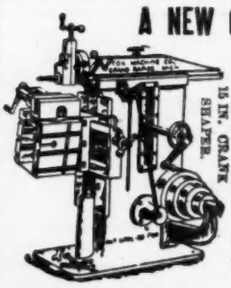

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